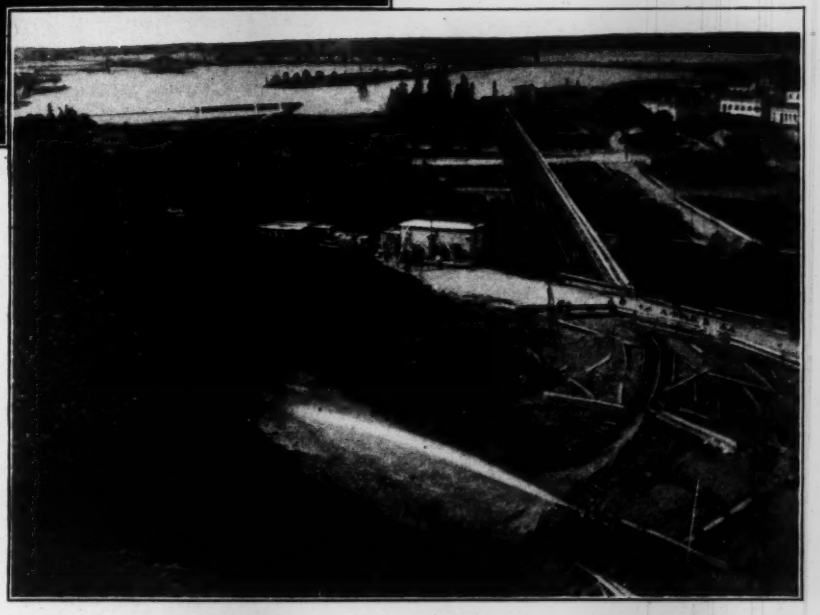
Engineering News

Vol. 67, No. 20. 505 Pearl Street, New York May 16, 1912

Hydraulic Regrading in Portland, Ore

Goldsmith Hill, an abrupt prominence in Portland, Ore., is being reduced with hydraulic giants and the spoil is being used for filling in a portion of Guild's Lake. The possibility of this improvement was suggested by the success in hydraulic regrading at Seattle, Wash. (See ENG. NEWS, Mar. 31, 1910.) The hill is largely of gravel and the streams are directed on the lower part of the bank so as to undermine and bring down the material above the working face. From the foot it is washed away through a sluice. The maximum height of bank to be reduced was 140 ft. The trestle supporting the sluice through which the waste is carried to the lake also supports two 18-in. pipes carrying the water pumped from the lake. The pump house is a temporary structure located near the lower end of the trestle. Its foundations were laid in the bottom of the lake at low water before any filling had been done, but now the pump house is in the middle of the filled tract. It is expected that the work will be completed by the spring of 1913, when the site of the hill will be available for about 300 residence lots; the operations will also reclaim for the city several acres of land in the lake. The pumping plant is capable of supplying 500,000 gal. of water per hour at 200 to 300 lb. per sq.in. gage pressure. There are two high-speed turbine pumps, direct driven by Westinghouse 650-hp. 2300-volt three-phase motors, and a booster volute pump directly connected to a 900-hp. motor.

HYDRAULIC REDUCTION OF GOLDSMITH HILL, PORTLAND, OREG.



VIEW OF SLUICEWAY CARRYING AWAY EXCAVATED MATERIAL

Tests on Compressed Steel Ingots

A careful and unusually extensive series of tests was made quite recently by the Prussian Royal Laboratory at Gross-Lichterfelde, Germany, on ingots compressed by the Harmet process. This process employs a tapered ingot mold and a hydraulic press which forces the material of the ingot upward into the narrow part of the mold during its solidification. The results of the tests have just been published in the "Mitteilungen aus dem Königlichen Materialprüfungsamt" pamphlet 1, 1912 (pp. 76, four folding plates) which may be referred to for full details. A brief abstract of the conclusions of the investigation is as follows:

Uncompressed ingots developed large pipes in the upper half, and I-beams rolled from them had a strong tendency to the formation of open seams or flaws

in the web, due to the pipes. The compressed ingots showed no piping.

Tensile tests of material from the web transverse to the length of the I-beam showed greatly reduced strength in the uncompressed ingot. The tensile tests showed generally in favor of the material from the compressed ingots. In notched impact tests there was practically no difference between material from the compressed and uncompressd ingots, but the test-piecs for these tests were taken from the flange, where there is little tendency to seam formation. A similar remark applies to the bend tests, the test-pieces for which were taken from points corresponding to the middle of the ingot. In the bend test at blue heat (350° C.), however, the uncompressed steel gave a slightly better bend, giving a 180° bend around a somewhat smaller radius than the compressed steel.

The general conclusion of the series of the tests is that the compression process was successful in preventing piping, and that all those parts of the finished material which would be affected by the pipe show the benefit of compression. Material rolled from that part of an ingot below the pipe is (by inference) just as good when made from an uncompressed ingot as when made from a compressed ingot. Surface flaws, which were noted in the nickel-steel I-beams particularly, are not peculiar to the compressed ingots but appear also in the uncompressed steel; they are attributable to the nature of the material and its treatment in rolling, etc., but not to the compression process.

In the test series there was no great segregation within the ingots, and the compression exerted little influence on the segregation.

The ingots tested were about 20 in. square by 5½ ft. high, and were of open-hearth steel. Three kinds of steel were used: Carbon steel of 0.21% carbon, carbon steel of 0.34% carbon and nickel-steel of 0.29% carbon and 1.78% nickel. Of each, four ingots were poured from a single heat, and two of these were compressed. One compressed and one uncompressed ingot were rolled to I-beams, and the other set cut in half for etching.

The Cumberland River Bridge at Nashville, Tenn., for the Lewisburg & Northern R.R. (Louisville & Nashville R.R. System), will be about 3000 ft. long with a maximum height of about 130 ft. There will be one 300-ft. and three 200-ft. through truss spans, and three 125-ft. deck truss spans; the balance of the structure will be of deck plate-girder viaduct construction. All piers for the through-truss spans will be founded on rock; the other piers probably will be founded on reinforced-concrete piles. The construction of the bridge is in the hands of the Foster-Creighton-Gould Co., engineers and contractors, of Nashville, Tenn.

A Simple Load-Weighing Apparatus for Large Testing Machines

The difficulties of weighing the applied loads in large testing-machines are so great that many constructors consider it necessary to dispense with weighing and rely on measuring the hydraulic pressure exerted by the ram which constitutes the power end of the machine. Recent researches have shown that the error involved in measuring the load by the hydraulic ram pressure is well below 5%. Still the uncertainties involved in accurate testing, when such errors are known to be possible, and when the factors influencing the variation of the error are not fully understood, are such as to make it highly desirable that each testing-machine be equipped with a reliable load-weighing apparatus. Lever scales for this purpose are difficult to construct and maintain, besides being very expensive. A new form of load-weighing mechanism, which was developed in Europe and is about to be tried out on a large scale at the Prussian Königliche Materialprüfungsamt at Gross-Lichterfelde, near Berlin, Germany, is therefore of interest.

In work done with large testing-machines hitherto the plan of frequently checking the accuracy of the load indication of the machine, by a test-bar whose extension or compression under given load had been previously determined with high accuracy, has been much used and is recognized to be the most accurate method of comparing and standardizing the indications of large machines. For routine use, of course, such a test-bar method is not directly applicable, because the extensometer measurements are tedious and delicate. By inclosing the test-bar in a case filled with liquid it has been found possible to measure the *volume change* of the test-bar by the displacement of the liquid, and to take this volume change as an index of the stress in the test-bar; in this form the test-bar may be made applicable to routine work.

The firm of Amsler-Laffon, in Switzerland, developed this idea into practical form some years ago. In another modification it has been employed by G. Wazau, of Geithain, Germany.

In the accompanying Fig. 1 the sketch *A* represents the device used by Amsler. Here he elastic body which measures the load is a cylindrical closed case. The change of the volume contained between this case and an inner core is measured by any suitable gage, most suitably by a micrometer plunger permitting the use of a zero method. Mr. Wazau's apparatus is represented by the sketch *B* in Fig. 1. Here the gage body is a cylindrical bar, which may be subjected to either tension or compression, surrounded by a case leaving a very narrow space between case and body for the reception of the displacement liquid.

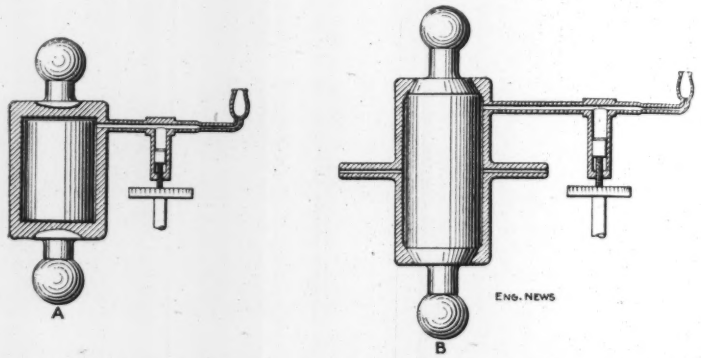


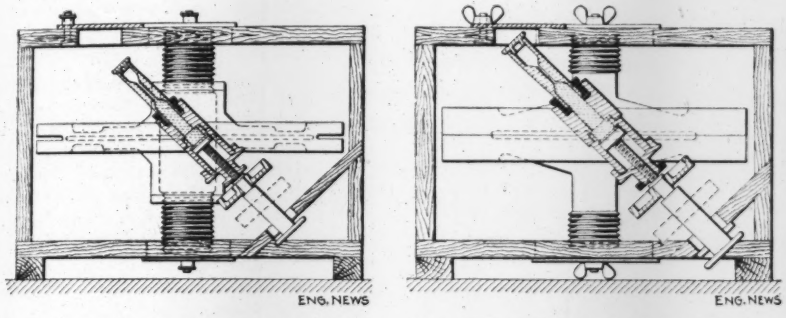
FIG. 1. DIAGRAMMATIC SKETCHES OF LOAD-GAGES OF AMSLER (A) AND WAZAU (B)

A recent article by Wazau, in *Zeitschrift des Vereines deutscher Ingenieure*, of Feb. 17, 1912, may be consulted. From it we take the two sketches reproduced as Fig. 2 herewith, which illustrate more concretely the construction which he employs.

Sketch (1) in Fig. 2, a gage designed principally for tension, shows a cylindrical bar to which the pull is applied, and a surrounding case which bears against shoulders on the bar and thus is spread apart when tensile elongation occurs. The gage shown by sketch (2) has a different principle of action, for here the hollow case is itself made strong enough to transmit the load, and its end-plates, by dishing slightly under load, change the volume of the narrow open space between. This gage can take compressive load as well as tensile. In calibrating it the relation between load and volume was found to depart slightly from a straight-line law, whereas the gage of sketch (1) had a true straight-line law. Since a diagram or table would in any case be used for converting the readings into loads, the

non-linear relation is not an important disadvantage.

Both the gages shown in Fig. 2 have attached to them micrometer displacement cylinders for reading. These are used on the zero-method principle, by turning the screw so as to bring the surface of the liquid to a fixed mark in a capillary tube at the end of the screw cylinder. For many uses, however, direct reading is preferable, and in such case vertical gage-tubes are applied to indicate the volume change without manipulation.



(1) 20-ton tension gage (dimensions, 10x8x7 in.)

(2) 20-ton tension and compression gage (dimensions, 9x7½x7 in.)

FIG. 2. TWO FORMS OF VOLUMETRIC LOAD-GAGE WITH READING SCREW, DESIGNED BY G. WAZAU

Prof. A. Martens, Director of the Gross-Lichterfelde testing laboratory, has developed the volume-gage principle in a rather different way for large-size work. He worked out a design for the load-weighing apparatus of a 3000-ton compression testing-machine which is being built for the Prussian laboratory. He described the apparatus recently in a paper read before the Königlich Preussische Akademie der Wissenschaften (also issued as a pamphlet reprint).

The 3000-ton scale is shown by Fig. 2, herewith. It consists of a lower body casting and an upper table casting. The

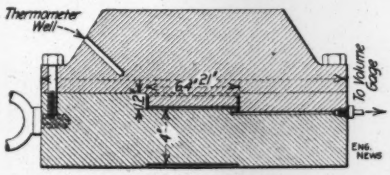


FIG. 3. VOLUMETRIC LOAD-GAGE FOR THE NEW 3300-TON TESTING-MACHINE OF THE KOENIGLICHE MATERIAL-PRUEFUNGSAMT, GROSS-LICHTERFELDE, GERMANY

two are secured together by screws near the periphery. The lower or body casting has a cylindrical bore in the center of its upper face, about 6¼-in. diameter by 1¼ in. deep. A projecting part of the table casting enters this bore, leaving a very narrow space around the wall and at the bottom. This space is filled with the displacement liquid. The load is applied at the top of the table casting and is transmitted through the lower face of the latter to the body casting. The compression of this body casting results in a slight lateral expansion of its metal, which changes the volume of the bore and therefore changes the space occupied by the displacement liquid. A tube connects the displacement space with a number of gage tubes on which the height of the water of the liquid column can be read at any time; this permits of measuring the volume change of the displacement space to any desired degree of accuracy. Prof. Martens estimates that readings to 0.1% of the maximum load capacity will be possible.

A load gage of this kind is acknowledged to be extremely sensitive to temperature variations, but Prof. Martens believes that by careful manipulation he will be able to overcome all temperature difficulties. The extreme compactness, small size and solidity of the device, together with its cheapness, will permit of utilizing it in a great variety of ways where large loads have to be measured and a continuous record of the load variations obtained. Prof. Martens suggests that such gages may even be useful in measuring reaction pressures, wind reactions and the like in bridges, chimneys or other structures.

The many attractive features of the apparatus will be clearly evident to those who are familiar with the requirements of test work. Should the prediction that temperature difficulties can be overcome without great trouble be verified, the apparatus should find a wide field of use.

The new testing-machine for which the gage shown by Fig. 3 is intended was illustrated in our issue of May 2, 1912, p. 841.

Government Ownership of Railways in Canada has always been an unprofitable investment. Now, however, the Government Inter-Colonial Railway is experiencing such a heavy traffic that according to newspaper reports from Ottawa the net earnings for the year will be upward of $600,000. The gross earnings of the road have doubled in the past ten years.

Engineering Problems in Alaska*

The presence of numerous large glaciers and glacial streams will introduce serious engineering problems whenever the extensive development of Alaska is undertaken. Already engineers have come in contact with obstacles which are to be met with almost nowhere else in the world and presenting problems not yet fully understood.

The interior of Alaska is defended against direct approach from the sea coast by an extensive, lofty, and practically continuous mountain range. There are few of the mountain passes which are not impassable by being filled or obstructed by glaciers, and in the few places where routes are feasible the torrential glacial streams which issue from the glacier fronts present engineering problems novel and difficult.

With the summer melting of a glacier a vast volume of water is turned into these streams, and with it is such a burden of sediment that it is wholly impossible for even such a torrent to transport all the sediment load to the sea. The water is so heavily charged with clay and sand that it is a thick chocolate brown in color, and the current is so rapid that one can hear the pebbles striking together as they roll along the stream bed.

Under these conditions deposition takes place in the stream bed soon after it leaves the glacier, and it requires but a short time to build up the stream bed so high that the water is diverted into other and lower courses. Consequently the stream divides and subdivides into a multitude of channels, constantly shifting in position. That a railway track laid through these valley bottoms will not hold its position through a single year has been demonstrated.

The problem of how to build stable bridges across these glacial streams is a serious one. In the interior, in crossing the Alaska Range, the government trail encounters several glacial streams, and in one place two attempts have been made to bridge the torrent, both of which have been unsuccessful, for the shifting stream has almost wholly destroyed the first bridge, and the second one is badly undermined.

Where the glacial torrents are pouring their waters into the sea the coast line is steadily and rapidly advancing, and will thus present knotty problems for the harbor engineers to come. The much-talked-of Controller Bay is shallow, and is, relatively speaking, being rapidly filled with sediment. Such a coast cannot be treated from the same viewpoint as is the coast of Maine, or Boston Harbor, or even the Mississippi Delta.

*Brief abstract of an article in the April issue of the "Harvard Engineering Journal" by the late Prof. Ralph S. Tarr, of Cornell University (died Mar. 21).

140,000-Volt Power Transmission

With the development of long-distance electric-power transmission, the line voltage has increased steadily in spite of difficultjes which increase with the voltage. When the first 110,000-volt transmission line was put in service five years ago, many considered reached the maximum commercial voltage. But early in 1912 the first 140,000-volt line was put in operation in Michigan, covering a distance of 125 miles, which soon will be increased to 235. The line is said to be working with entire success in regular service. The generating plant on the AuSable River presents interesting features independent of the transmission line. This article describes both.

An electric transmission line put in service early this year presents a marked increase in voltage, carrying 140,000 volts as compared with a previous maximum of 110,000, and this latter being employed only in a limited number of cases. Prior to the adoption of 110,000 volts, many electrical engineers had considered that so high a voltage could not be commercially practicable, but the satisfactory operation of the first line led to the adoption of the same voltage elsewhere. This experience may be repeated with the still higher voltage. It is of interest to note that the first 110,000-volt line and the first 140,000-volt line were both built in Michigan, and both designed by the same electrical engineer, J. B. Foote. The former was the Grand Rapids and Muskegon line, 44 miles, built in 1907. The latter is completed from the Au Sable River to Flint, 125 miles, and will soon be extended to Battle Creek, making a total length of 235 miles. The route of this new line is shown in Fig. 1.

The prime reason for the increase in voltage is to reduce the copper cost in the expense of construction; on the present 125-mile line there is a saving of approximately 50% in copper as compared with the cost of a line working at 100,000 volts. There is, of course, an economic limit to the increase in potential. There has been an impression that a 140,000-volt line can be operated continuously and economically only in a dry climate, on account of the direct leakage of current from wire to wire, through the air; at about this voltage the air in the vicinity of the wire commences to break down as an insulator, and this effect is more or less independent of the spacing of the wires. However, it appears that no serious amount of leakage of this kind has been experienced on the new line, although with 140,000 volts on the power-house end of the line the voltage may be as high as 160,000 volts at the substation end under no-load conditions, and on account of the capacity effects.

Current is generated at the Cooke hydro-electric plant on the Au Sable River, whence the high-tension line runs south 85 miles to a substation at Zilwaukee (a switching and distributing point from which 20,000-volt lines run to Bay City and Saginaw) and thence continues south to Flint, 40 miles. This stretch of 125 miles is now operating at normal tension, and has been tested to 145,000 volts. From Flint an extension of 30 miles is being built to Owosso, where it will connect with an existing line to Lansing and Charlotte, 50 miles; a branch runs also from Lansing to Jackson, 37 miles. These two lines were built with a view to carrying 140,000 volts, but are at present operating at 40,000 volts; with the installation of new suspension insulators they will be adapted to the higher voltage. From Charlotte the line is being extended 30 miles to Battle Creek, making a total distance of 235 miles from the generating station. This power-generating and transmission system is owned by the Au Sable Electric Co., which is related closely to other similar systems in Michigan. W. M. Eaton, B. C. Cobb and W. A. Foote form the executive committee of the board of directors; J. B. Foote is the general manager, and Wm. G. Fargo is the civil and hydraulic engineer.

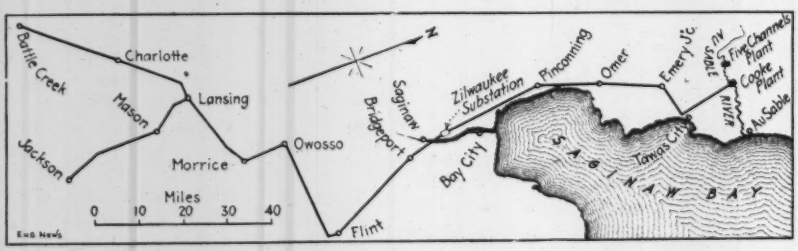


FIG. 1. MAP OF 140,000-VOLT TRANSMISSION LINE IN MICHIGAN; AU SABLE ELECTRIC CO.
(Cooke power plant to Battle Creek, 235 miles.)

POWER PLANT

The power plant (known as the Cooke development) is the first of a proposed chain of hydro-electric plants generating power from the Au Sable River, and all supplying current to the 140,000-volt transmission line. The second plant is already under construction at Five Channels, eight miles higher up the river. Both plants are shown in Fig. 1. The Cooke plant is 16 miles from the mouth of the river, and about the same distance from the nearest town (Au Sable). It is out in the wilderness and accessible only by a five-mile spur built from the Au Sable & Northwestern Ry., which is a logging road of 3-ft. gage. The Au Sable

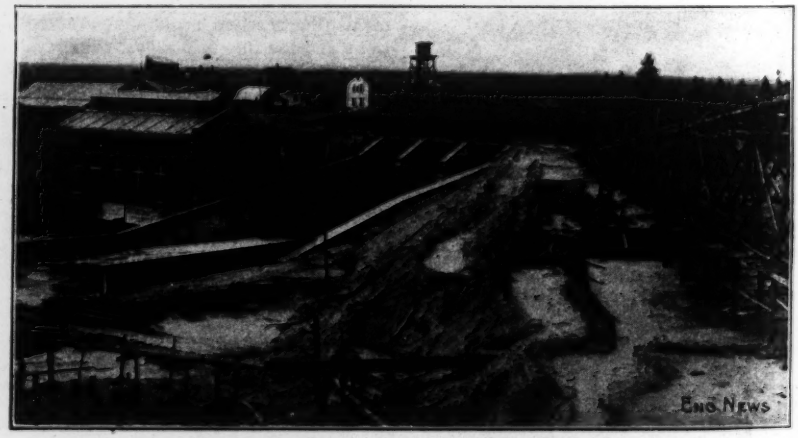


FIG. 2. THE COOKE HYDRO-ELECTRIC PLANT ON THE AU SABLE RIVER, MICHIGAN
(The power house is at the left, and adjacent to it is the spillway, having three gates; at the right is the trestle for the sluicing flume used in making the hydraulic-fill embankment.)

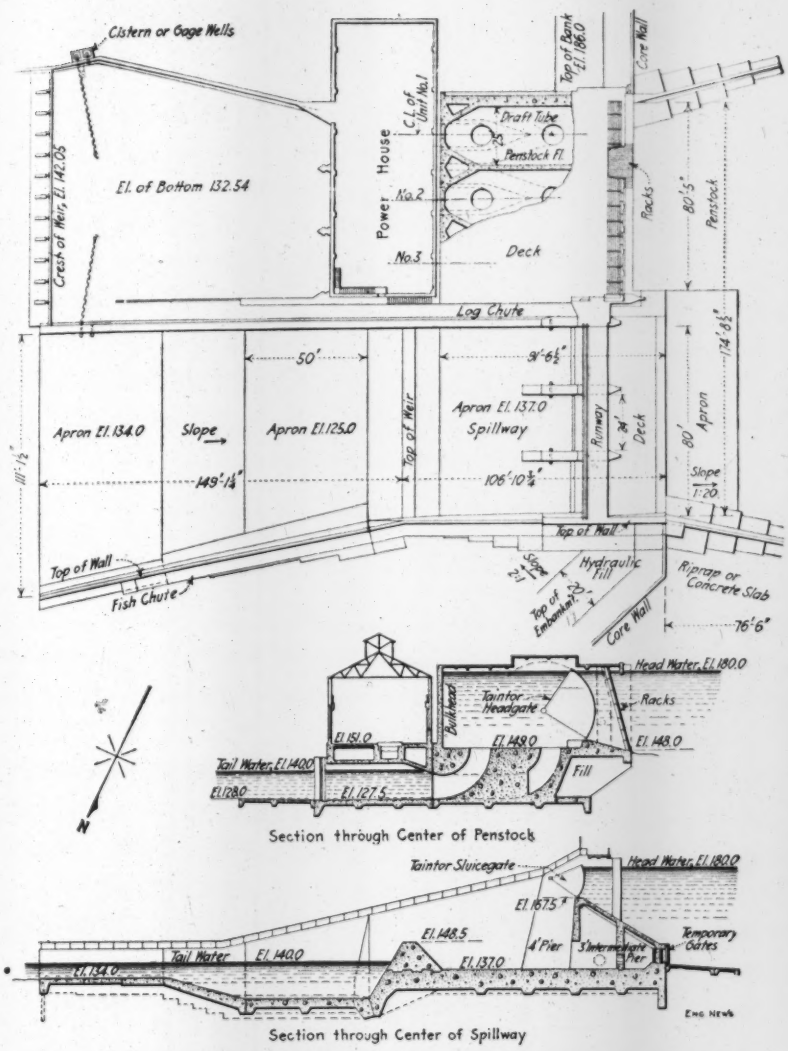


FIG. 3. PLAN AND SECTIONS OF THE COOKE HYDRO-ELECTRIC POWER PLANT ON THE AU SABLE RIVER, MICH.

River has a very uniform flow, the dry weather and maximum flow being respectively about 1100 and 3500 cu.ft. per second. The dam forms a reservoir of about 1920 acres, with a drainage area of 1640 sq.miles. The soil is mainly sand, but it is underlaid at a depth of 20 to 30 ft. by a deep bed of red clay; this clay is hard and impervious, and as its surface slopes toward the river the greater proportion of the rainfall is delivered to the river. The river has few tributaries and none of these are of any size or importance. The Cooke development has a working head of 40 ft., while at Five Channels the head will be 35 ft.

The Cooke plant is built across the river channel, and has a length of about 175 ft., exclusive of the embankments at each end. A plan and sections of the plant are shown in Fig. 3. On one side is an 80-ft. penstock chamber opening into three 25-ft. covered penstocks in which the turbines are placed; directly behind the end wall or bulkhead of the penstock is the generator house. On the other side is the spillway, having a crest length of 72 ft. It is divided by piers into three 24-ft. sections, each of which has a Taintor gate 24 ft. wide and 13 ft. high. Over each gate is a shaft carrying two drums for the operating chains, and the shaft is driven by a 7½-hp. motor. The gates are normally lowered, resting on the crest of the dam, so as to raise the head water to the desired level. On one side of the spillway is a 6-ft. log chute, and on the other side is a 6-ft. fishway or fish chute. All this work is of concrete (except the superstructure of the generator house), and it is flanked on each side by an earth embankment with a concrete core wall. Fig. 4 is a general view of the downstream side of the plant, and at the right is the trestle carrying the flume for the hydraulic fill.

Two special features of the power plant are (1) the use of Taintor gates for the headgates at the upper ends of the penstocks, and (2) the construction of a permanent weir in the tail race for making tests of the hydraulic efficiency of the plant.

HEADGATES—This use of Taintor gates for the headgates is very exceptional, and is the first case of the kind in this country. The gates, shown in Fig. 5, are 25 ft. wide and 20 ft. 6 in. high, with a radius of 20 ft. The piers between the penstocks have grooves for stop-logs, and support the usual inclined trash racks in front of the gates. The gates are raised and lowered by chains attached to the bottom edge of the gate and wound upon drums on a shaft supported on a bridge over the penstocks. Each gate shaft is operated by a 5-hp. motor, which is to be controlled from the main switchboard in

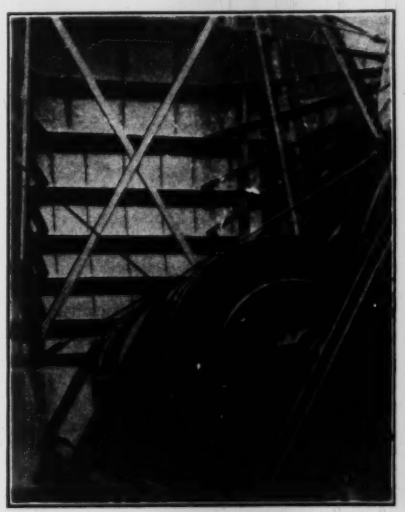


FIG. 4. INTERIOR OF PENSTOCK, SHOWING THE TURBINE AND TAINTOR HEADGATE

the generator room, so that the station operator has full control of the gates.

The bottom of the gate is fitted with a sill block of white oak, which takes a bearing on a ribbed steel plate set in the top of the concrete sill and attached to stirrup anchors embedded in the concrete. At each end of the upper edge of the gate is a white-oak stop block; when the gate is raised to its full limit these butt against stops projecting from the sides of the piers. Along each end of the gate is fitted a strip of rubber belting to make a water-tight joint with the side walls. Fig. 4 is a view in one of the penstocks, with the gate closed, and showing the turbine.

TESTING WEIR—For the testing weir, which has a length of 108.6 ft. on the crest (as shown in Fig. 3) there is a row of vertical posts (9 ft. apart) across the tail race. Each post is an 8-in. H-beam with a back brace formed of a pair of

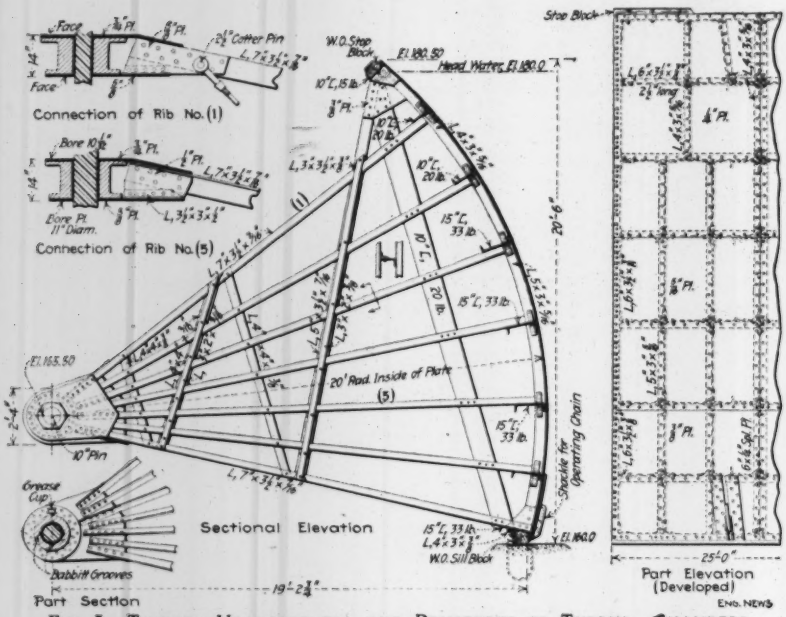


FIG. 5. TAINTOR HEADGATE FOR THE PENSTOCKS OR TURBINE CHAMBERS

(This is the first plant in this country having headgates of this type.)

angles, the posts and braces being anchored in the concrete floor. Bolted against each side wall, and in line with the posts, is a vertical timber post 4x8 in. The construction is shown in Fig. 6. Between the posts are dropped wickets about 9 ft. square, built of horizontal timbers or girts fitted between the flanges of the H-beams and faced with $\frac{3}{16}$-in. steel plates secured by coach screws in countersunk holes. At the bottom of the wicket is a 6x8-in. timber beveled to fit the concrete sill on the floor, this sill being faced with a ribbed floor-plate having horizontal grooves which serve to form water stops and prevent leakage between the sill and the wicket. On each H-beam is a 5-in. strip of heavy felt, cemented in place with hot asphalt so as to make a watertight joint.

Provision is made for taking the elevation of the water in the pool at four points by means of pipes, which lead to four cisterns or gage wells (Fig. 3). At each side of the tail race a 2-in. pipe is run through the wall, extending vertically into the pool on one side of the wall and into a gage well on the other side. Two other pipes are laid under the floor of the tail race and extend from gage wells to two concrete pedestals on the floor. The opening in the top of the pedestal is tapered, and is normally closed by a wooden plug; a wire attached to the plug carries a small buoy, so that the plug can be located and removed at any time. Permanent bench marks have been established for referencing the water levels.

All the work of the dam and power station is of reinforced concrete; but the superstructure of the generator room is of brick, with steel roof trusses. The foundations are in the bed of hard and impermeable clay mentioned above, and no piling was required except under one of the wing walls, which extended over a softer clay; here about 30 piles were driven. The penstock concrete is made with natural bank gravel, using 1:5 mix, and although no waterproofing was employed the work has proved dry and watertight under a head of 30 ft. At the spillway, openings were left through the toe to carry off any flood water during construction, as shown in the section, Fig. 3. After the completion of the dam these openings were closed by timber flap gates, and then sealed with concrete. During the construction, the river was diverted to an old channel by means of a crib dam.

HYDRAULIC FILL—The embankment adjacent to the spillway is about 550 ft. long, and was built by hydraulic sluicing. This bank contains about 156,000 cu.yd., most of the material being sand, but with some 9800 yd. of clay. The hydraulic excavation was done with water pumped through 800 ft. of 12-in. spiral riveted pipe to 4-in. hose lines having 1⅛-in. nozzles, the pressure at the nozzle being about 90 lb. per sq.in. The stream of water and sand was carried in a sluicing trough laid along a trestle at grades of 6½ to 8%. The trough was semicircular, 15 in. radius, built of No. 12 sheet iron, and the water was normally 4 in. deep when only one pump was supplying the jets. The velocity on the steeper grade was about 17 ft. per second. When handling sand, the proportion of solid matter to total volume of water pumped was from 49 to 65%, but with clay it was only 16%. The

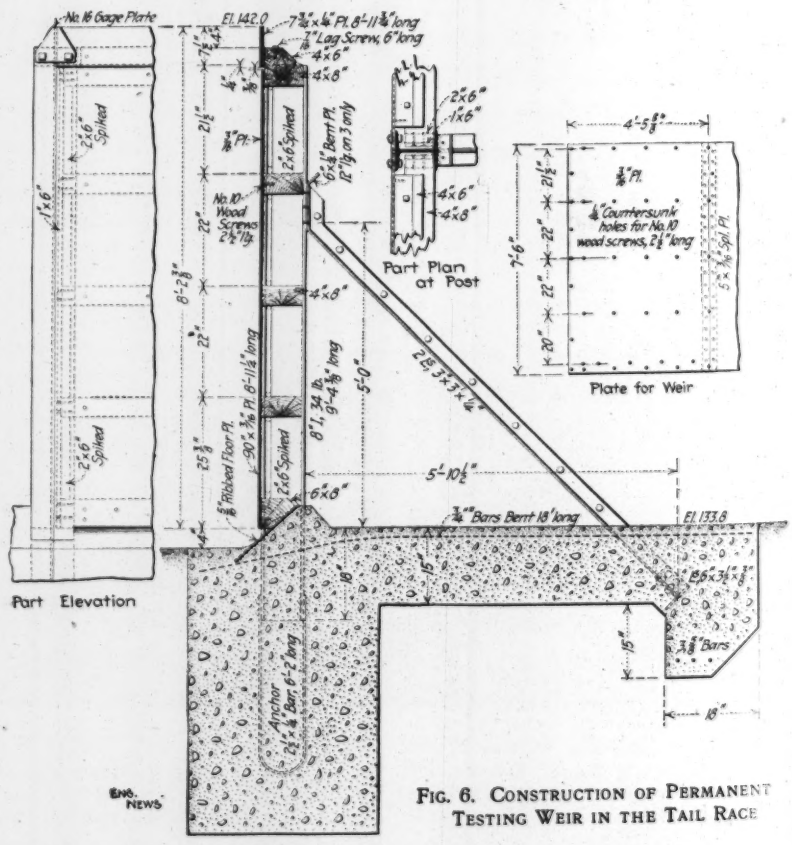


FIG. 6. CONSTRUCTION OF PERMANENT TESTING WEIR IN THE TAIL RACE

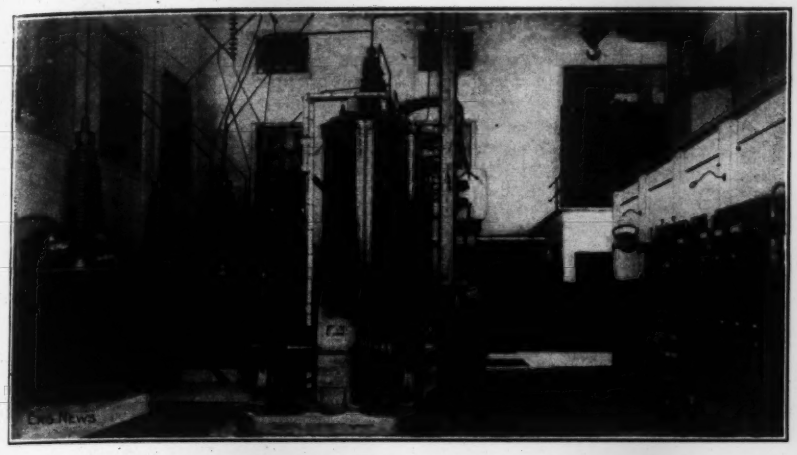


FIG. 7. INTERIOR OF 140,000-VOLT SUBSTATION AT ZILWAUKEE, MICH.

(The transformers are in the middle; at the left are the oil-switch tanks, with the terminals projecting from the top; in the recesses above these are the entrance bushings on the 140,000-volt cables.)

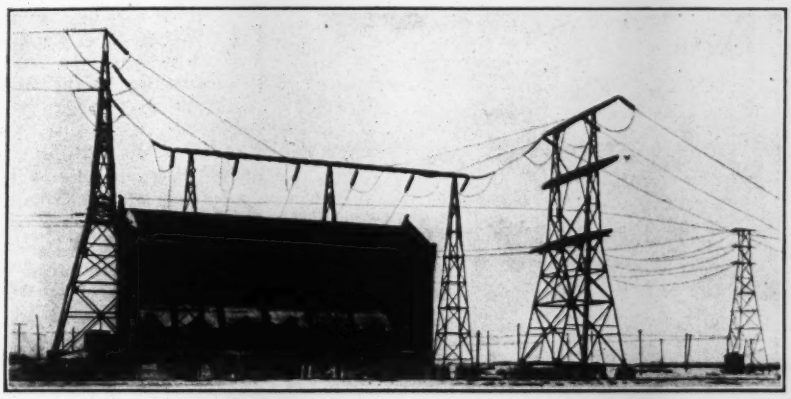


FIG. 8. EXTERIOR OF SUBSTATION AT ZILWAUKEE, MICH.

(The 140,000-volt line comes in at the right from the power house, and goes out at the left to Flint, etc. Along the side of the building are the six high-tension cable entrances.)

average for the entire job was 38½% of solids. In Fig. 2 are shown the bank, the 12-in. main and the trestle for the flume.

CONSTRUCTION CAMP — For sanitary purposes, and to insure efficient work, the company (owning the land adjacent to the site) established very careful regulations for the construction camp. Streets and lots were laid out, a water-supply system installed, and also a sewer system having a slop or drain inlet for each four lots. Each lot was leased to a laborer, with authority to erect a dwelling (on a specified location), for the use of himself and family, and with permission also to board two relatives. No general boarding was permitted for these dwellings, and no liquor kept or sold. The occupants constructed branch drains to the main sewers, as directed by the camp superintendent. The dwellings were required to be adequately screened and fitted with self-closing screen doors, so as to exclude flies and mosquitoes. All solid waste too large for the drain grating was required to be burned or buried in small pits. The average number of men on the work was about 250. Food was supplied by the company and served to the unmarried men at the dining room. Italians, however, preferred to do their own cooking.

STATION

The power station has three generating units, each consisting of two pair of horizontal turbines in the flume or penstock, with the shaft extending through the bulkhead wall and the wall of the generator room for direct connection to the generator shaft. There are two draft tubes in each penstock, that of the forward pair of turbines being split or forked so as to pass on both sides of the draft tube of the rear turbines. These three passages extend under the floor of the penstock, and unite under the power house in a 24-ft. opening which in turn opens into the tail race. The hydraulic equipment was built by the Allis-Chalmers Co. and the electrical equipment by the General Electric Co.

HYDRAULIC EQUIPMENT—The turbines are of the open-flume quadruplex type, developing a maximum of 4150 hp. with 38-ft. effective head. The main shaft is of nickel steel, made in three sections to facilitate erection and having the inner end flanged for direct connection to the generator shaft. It has four main bearings in the turbine flume, all having adjustable lining blocks of lignum-vitæ. In the generator room it has a ring-oiling bearing, which is built also for thrust. The runners (four in each turbine) are of cast iron with steel-plate vanes, and the central discharge casings are so designed as to carry the water from the runners to the draft tube with the least possible disturbance. The guide vanes are of the swivel type, to allow of high economy at light loads. In the gate rigging all sliding surfaces are lined with renewable bronze plates. Grease lubrication is provided for the lignum-vitæ bearings and the gate rigging; a grease compressor is used, with individual piping, so that each bearing and each joint of the gate rigging can be supplied with grease automatically.

The governor is of the oil-pressure type and of new design. It is mounted on a pedestal which contains the speed-controlling apparatus, flyballs, relay, regulating valve and synchronizing attachment for switchboard control. The regulating cylinder is separate, and is so located that its connection to the regulating shaft is as direct and rigid as possible. It carries also a mechanical hand-operated regulating device, so that the unit can carry its load independently of the governor if the latter should be shut down. The oil pump is of the rotary type, driven by a belt from the main shaft, and the pressure tank is located directly above the pump base. The oil receiver tank is placed beneath the floor, so that all return oil can be drained to it by gravity. A mechanical brake is placed directly on the turbine shaft in the flume, close to the bulkhead. This

FIG. 9. ENTRANCE BUSHINGS FOR 140,000-VOLT CABLES

(The cable is attached to the horizontal insulated hanger beneath the window, and drops in a loop to the bushing, which projects through the frame of the inlet chamber.)

brake is operated by hand by means of mechanism extending into the generator room. Very rigid guarantees were required both as to efficiency and speed regulation of the turbines; these were exceeded by a wide margin. A maximum efficiency of 89% at best gate opening and 79% at half-load were obtained on official test, the guarantees having been 84% and 75%, respectively. It is noted by the builders that the test showed the same efficiency characteristic as the guarantee, and the fact that the test curve is almost exactly parallel to the guarantee curve is regarded by them as evidence that modern turbine design can produce runners strictly in accordance with predetermined characteristics.

ELECTRICAL EQUIPMENT—The electric end of each unit is a three-phase 60-cycle 2500-volt alternating-current generator of 3000 kw., and on the outer end of the generator shaft is a 32-kw. 125-volt interpole exciter.

The current from the generators is delivered to a bank of three 3000-kw. water-cooled oil-insulated transformers which step it up from 2500 volts to 140,000 volts. These transformers are about 11½x6 ft. and 15 ft. high. Behind them is a three-pole non-automatic hand-operated oil switch, with tanks 8x4 ft. and 12 ft. high. Piping and pumps are provided for handling the oil for tanks.

The type of terminal and contact used in the transformers and switches is shown in the interior view of the Zilwaukee substation, Fig. 7; they have a total length of about 4 ft., are composition filled and carry pressboard disks. In Fig. 7, the transformers are in the middle, with the switchboard at the right. At the left are the oil-switch tanks, and above them are the indoor ends of the insulator bushings for the cable entrances mentioned below. These are in an inclined position, fitted to frames outside the wall of the building. Points and edges on 140,000-volt conductors have been eliminated everywhere.

and substation are bushings 10½ ft. long, composed of a series of porcelain disks on a central tube. The bushing is fitted to a cast-iron ring in a frame projecting from the side wall at an angle of 45° and forming the lower side of an inclosure extending 7 ft. from the building, as shown in Fig. 9. The lower frame

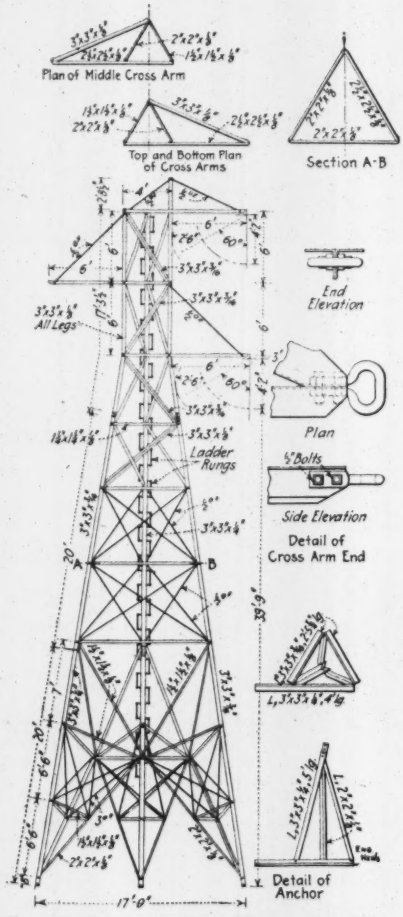


FIG. 10. STANDARD LINE TOWER FOR 140,000-VOLT TRANSMISSION LINE

building and then loops down to the entrance bushing. These inlets are ... ft. apart, the spacing of the transformers. A minimum clearance of 5 ft. between the 140,000-volt conductors and ground has been maintained.

TRANSMISSION LINE

The 140,000-volt transmission line is on a private right-of-way, 50 to 100 ft. wide, and consists of three No. 0 (⅜-in.) copper cables (each composed of seven No. 8 wires). These are suspended from arms on steel towers by insulators 5 ft. 3 in. long, each built up with ten 10-in. porcelain disks. On one side of the tower are two conductors, 12 ft. apart vertically; and each of these is 17 ft. 4 in. from the third conductor on the opposite side of the tower. The latter is a braced tripod type composed almost entirely of galvanized-steel angles; each leg is attached to a steel anchor embedded in the ground. The normal height is about 56 ft. (40 ft. to the lowest wire), but varies with the topography. The construction of the standard tower is shown in Fig. 10. The towers are spaced 528 ft. apart, and the cables have a sag of about 12 ft. for this span. At corners, the towers are of the same type, but built up of heavier members. At these towers the ordinary suspension insulator is replaced by two insulators of the same type attached to each crossarm and extending practically horizontal as a part of the cable span (very much as shown at the left in Fig. 8). Between the outer ends of the two insulators the cable forms a 12-ft. loop. These towers were built by the Aermotor Co., of Chicago. Each standard line tower weighs about 2200 lb., including anchors, and is capable of sustaining a horizontal load or pull of 1800 lb. applied simultaneously (in the direction of the line) to each of the three insulator supports. Each corner tower weighs about 3200 lb., and is capable of sus-

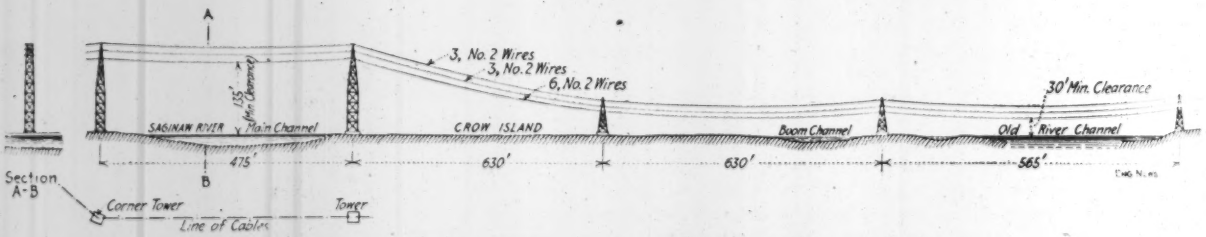


FIG. 11. SAGINAW RIVER CROSSING OF 140,000-VOLT TRANSMISSION LINE

Fig. 8 is a view of the Zilwaukee substation, with the transmission line from the power station at the right. Special towers are used here to carry the system for wires entering and leaving the station, and beneath the windows of the buildings may be seen the six cable entrances for the 140,000-volt lines.

The cable inlets at the power house is closed with steel plates, while the upper portion is covered with reinforced-concrete sheathing so that the inlets are entirely closed and weatherproof. The upper part projects far enough from the building to prevent water dropping from the roof upon the entrance bushing. The outdoor cable is attached to a 10-disk insulator fastened to the wall of the

taining a triple load of 3150 lb. applied as above.

At Zilwaukee the transmission line makes practically a right-angle turn to cross the Saginaw River. This turn is divided into two parts, the first being a diagonal span (318 ft. long) from a tower at the end of the direct line to a tower at the river bank, and the second

being the river crossing to the opposite bank. Thus the first river tower is (in plan) diagonal with both lines of cables carried by it. This is shown by the part plan in Fig. 11, the elevation being given for the entire crossing. The navigable channel is crossed by a span of 475 ft. between towers, and a clear headway of 135 ft. is given to meet the government requirements.

Two special towers were used for this span, and were built by the Lackawanna Bridge Co. Their construction is shown in Fig. 12. They are rectangular in plan with each leg resting on a concrete pedestal; the spread at the base is 18x18 ft., and the height from the top of the concrete is 167 ft. The four pedestals of each tower are connected by 10-in. curtain walls and have footings 10 to 12 ft. square, forming a single pier or foundation, as shown in Fig. 13. One of the towers has nine piles under each footing, the footing being anchored to them by a pair of hoops or straps bolted to the pile and extending above its top into the concrete. On the inside of the pier, gravel or clay is filled in level with the tops of the curtain walls, while on the outside the fill is graded to about 2 ft. below these walls. The steelwork was given a shop coat of red lead and two field coats of graphite paint, but the part to be embedded in the concrete was left unpainted. The two towers are shown in Fig. 14, and the difference in their appearance is due to the fact that the one at the left (at an angle in the line) is set diagonally to the line between the towers, while the other one is set perpendicularly to this line, as explained above.

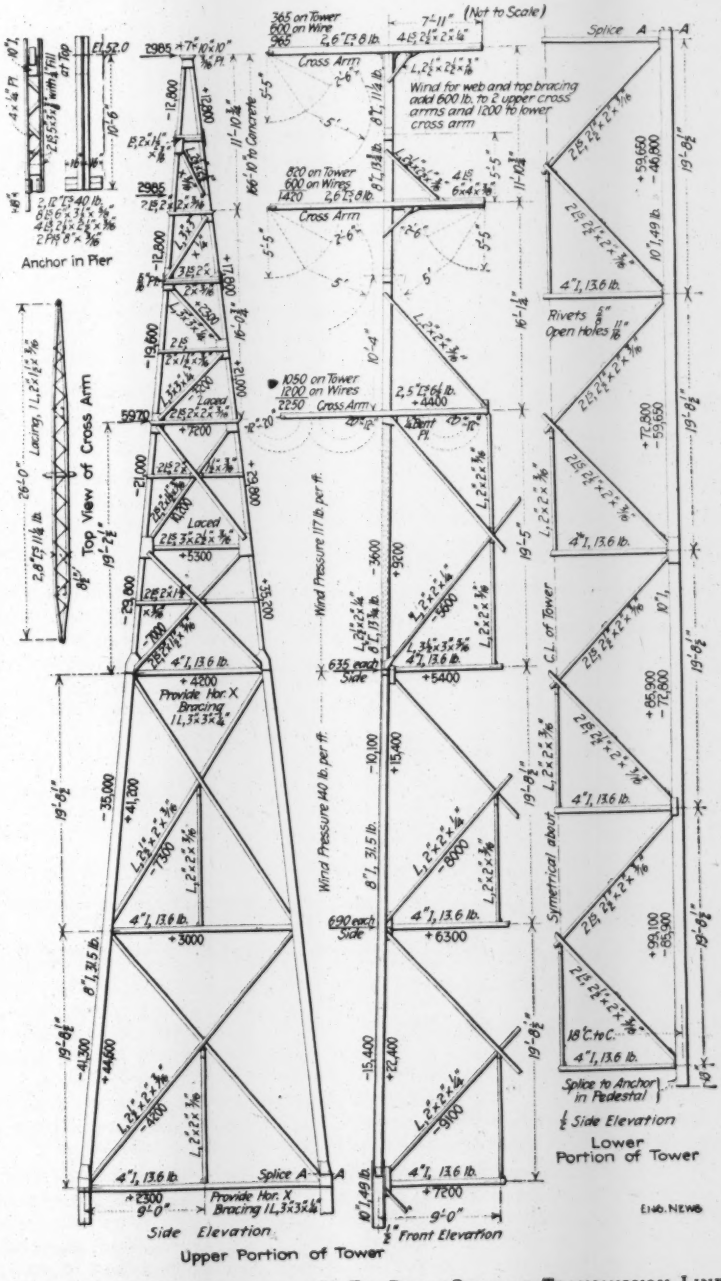

Anchor in Pier
Top View of Cross Arm
Side Elevation
Upper Portion of Tower
Lower Portion of Tower
Splice A
Cross Arm
Wind for web and top bracing add 600 lb. to 2 upper cross arms and 1200 to lower cross arm
Rivets 6" Open Holes 11"
Wind Pressure 117 lb. per ft.
Wind Pressure 140 lb. per ft.
C.L. of Tower
Symetrical about
Provide Hor. X Bracing
Splice to Anchor in Pedestal
Front Elevation
ENG. NEWS

FIG. 12. 167-FT. TOWER FOR 475-FT. RIVER SPAN OF TRANSMISSION LINE

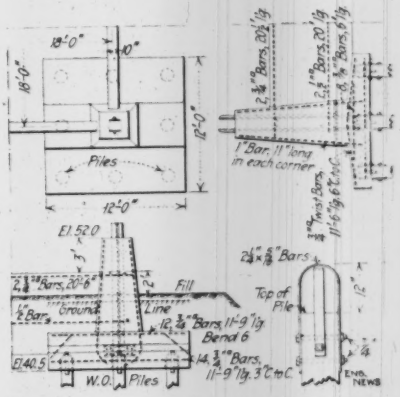


FIG. 13. FOUNDATION FOR 167-FT. TOWER

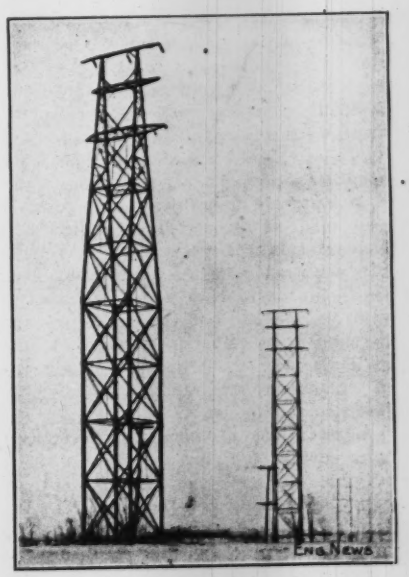


FIG. 14. 167-FT. TOWERS FOR 475-FT. RIVER SPAN OF 140,000-VOLT TRANSMISSION LINE ACROSS THE SAGINAW RIVER AT ZILWAUKEE, MICH.

This river crossing carries two 140,000-volt lines, one 20,000-volt line and one 10,000-volt line. It has three No. 2 cables on the top arm, three on the second and six on the bottom arm.

Rapid Construction of a Small Concrete Bridge

By P. E. Green*

The following article gives a complete exposition of the construction of a typical small highway bridge, such as are being erected in this country every year by the thousand. The rapidity of design and construction is especially noteworthy, only three days intervening between the calling in of the engineer and the advertisement for bids and only nine days between that advertisement and the awarding of the contract. The bridge was completed 90 days later.

Special attention is called to Mr. Green's remarks on the necessities for state supervision of highway bridge construction.

*Consulting Engineer, 17 N. La Salle St., Chicago.

The DesPlaines River in northwestern Illinois is a rather sluggish stream, normally about 150 ft. wide at the water surface and having a considerable variation in its flow, but not a very rapid current. Across the river between the villages of Riverside and Lyons, in Cook County, Ill., was an old steel bridge consisting of five 45-ft. Pratt trusses erected about 1880, the total length being about 250 ft. A very considerable automobile and wagon traffic uses the highway. In the course of time the condition of the bridge had become dangerous, this being very largely the result of inefficient maintenance. In the summer of 1911 the Highway Commissioners of the Townships of Lyons and Riverside decided that it was necessary to condemn the bridge, close it up and build a new one. This decision was due to the fact that the old stone piers, though repeatedly pointed up, were giving every sign of early failure. The wood floor of the old bridge was also so rotten that wagons were frequently breaking through and many damage suits were threatened.

On July 22, 1911, on an emergency call, the writer was instructed to make plans for a new concrete bridge so that the contract for constructing the same could be let at the earliest possible moment. Advertisement for bids followed on July 25, and on Aug. 4 the bids were opened and the contract awarded.

As complete investigations as possible were made in the extremely limited time at the disposal of the engineers. Soundings were taken for the foundations, data looked up as to high water, etc., and it was determined that bed rock was apparently at an elevation of about +85.0, or a distance of 20 ft. below the grade of the highway, and the high-water elevation was about. +98.5.

Comparative sketches and estimates were made for three different span lengths, the total overall length in all cases being about 250 ft. No. 1 was for three 75-ft. arches, No. 2 for five 45-ft. arches and No. 3 for four 56-ft. arches. These spans were used because the total length was strictly limited, and since the width of piers and abutments can be closely estimated before the actual design is made, the span lengths are found at once by dividing by the number of spans desired. Design No. 1 called for 1350 cu.yd. of concrete, No. 2 required 1200 cu.yd. of concrete and No. 3, 1215 cu.yd. Design No. 3 was therefore selected, since it was almost as cheap as the five 45-ft. arches and had one less pier to present as an obstruction to the current. From the standpoint of lessening obstructions to the flow of water, a bridge having three 75-ft. spans was still better, but the amount of money was limited, and, as has been stated, though the variation in the level of the water in the DesPlaines River is considerable, being about 14 ft., still it is not accompanied by a very rapid current. The bridge as designed (Figs. 1-2), while not having so great a water way as the old steel bridge, would offer considerable less obstruction to the flow, since there would be only four piers in place of five in the old bridge. The elevation of the intrados was fixed at 102, or about 4 ft. above extreme high water, a roadway of 20 ft. adopted and one sidewalk 5 ft. wide provided. The bridge was designed to carry a roller of 15 tons weight and a single-track electric railway, and in the computations a uniform live load of 200 lb. per sq.ft. was used to provide for these assumptions. The arches are three-centered, having a rise of 9 ft. above the springing line.

On Aug. 4, the contract, calling for approximately 1228 cu.yd. of concrete in place and including backfilling and the construction of a tar-macadam pavement over the roadway, was let for lump sum price of $21,687, with a price for extra concrete of $15 per cu.yd. This method of letting bridge work is almost universal in Illinois. It certainly cannot be commended, but the custom is so strong that it seems impossible to change it. It is manifest that such a method is a wide-open invitation for extras. The plans called for 423 cu.yd. of 1:3:6 concrete, 805 cu.yd. of 1:2:4 concrete and 98,548 lb. of reinforcing steel.

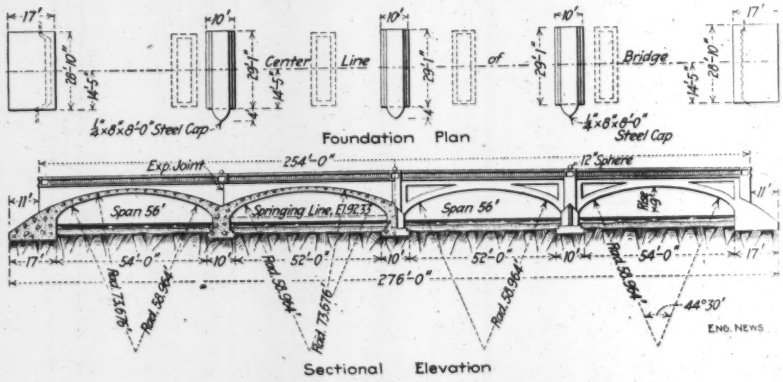


FIG. 1. ELEVATION AND PLAN OF A 250-FT. REINFORCED-CONCRETE BRIDGE ACROSS THE DES PLAINES RIVER

CONSTRUCTION

The contractor organized his plant and force as rapidly as possible and two weeks later (on Aug. 18) the first span of the old bridge was demolished. At the beginning only one span was taken down, that being the west one, and the contractor began his excavation for the west abutment working off of the old bridge with the west span removed.

TEARING DOWN OLD PIERS—On tearing down the old masonry piers and abutments, it was found that they were in exceedingly bad condition, the wonder being that they had not failed years before. They consisted of mere shells of rubble masonry, resting on old piers driven about 18 in. into the bed of the stream, the inside having been filled with earth. These old piles were so rotted that they could be pushed over with little difficulty.

Excavation at the west abutment developed that the soundings for this point were approximately correct, solid rock being found at an elevation of 85.6 ft. above datum. This was overlaid by several feet of extremely hard boulder clay, which would in itself have made an excellent foundation. As rock was so close, however, it was insisted that the foundation be carried down as shown on the plans, and this was done. The west abut-

night, up to the haunches, was concreted on Aug. 27 and 28. Stub bars to be used for anchoring the reinforcing bars in the arch ring were embedded in this foundation.

The work of tearing down the old bridge then proceeded, the next span being demolished and coffer-dams constructed for the piers. These coffer-dams were built by using the old masonry pier for one side where practicable, and the other side consisted of two rows of sheeting driven to the river bottom, and the rows being spaced about 2 ft. apart. The space between was filled with clay and puddled. On account of the sand overlying the rock in the bottom of the river, considerable difficulty was encountered in keeping the coffer-dam dry. In the same manner the footings of all four spans were constructed, the spans of the old bridge being torn down as the work proceeded. It was found that the elevation of the rock varied somewhat, dipping generally toward the east, and at the east abutment the elevation of bed rock was found to be at +80, a distance of 6 ft. lower than the west pier. Over all was found a mass of boulders, and at the east abutment it was not deemed necessary to carry the foundation down to the bed rock, but excavation was stopped at elevation +84. This was done because, as has been stated previously, the money available was limited; and, since the abutments were so massive, it was an expensive matter to carry them down to elevation +80, and the boulders themselves formed a first-class foundation. By stopping at elevation +84, 72 cu.yd. of concrete was saved, at $15 per yd., or $1080.

PIERS—For the construction of the piers a mixer was mounted on the old bridge, and the concrete deposited by means of chutes. In all foundations a 1:3:6 mixture of cement, screenings and stone was placed rather wet, being thoroughly spaded in order to get a dense mass and a smooth finish. The first pier was constructed Aug. 31, the second Sept. 1, the third Sept. 12, and the east abutment about Sept. 28, just one month after concreting the west abutment.

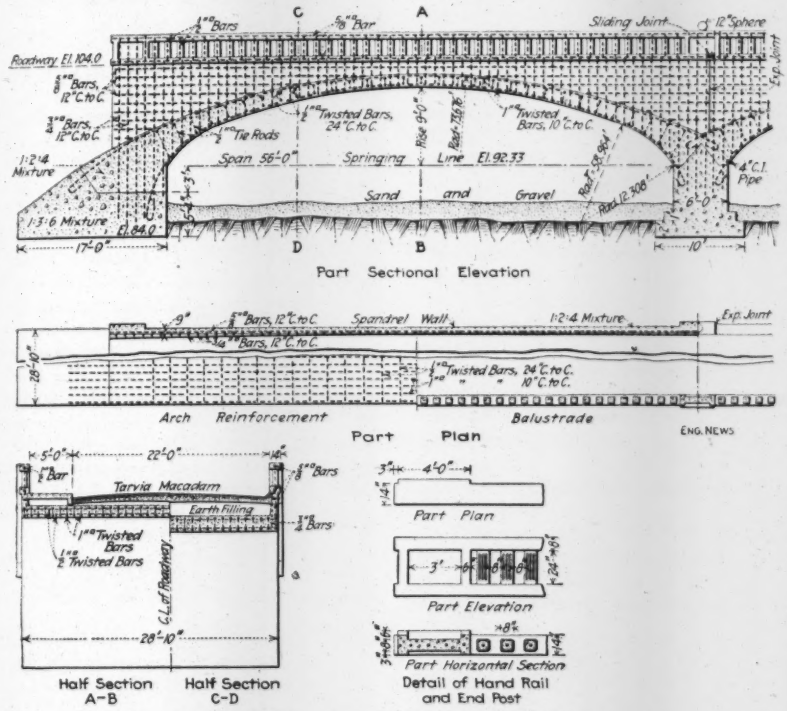


FIG. 2. DETAILS OF ARCH CONSTRUCTION

The piers were finished to the springing line in one operation, and after they were well set the arch centers were placed for the first span. The temporary piers upon which the centers themselves rested consisted of four lines of concrete footings 2 ft. square and placed under the panel points of the false work. On these footings were placed 6x6-in. posts of such a length that a 6x8-in. sill would be to a proper grade. On each sill were placed eleven pairs of wedges, so that each pair would be under a center. Two 2x6-in. planks were nailed together and placed on the wedges, the arch centers resting on these. The centers themselves were placed 34 in. c. to c., except the two at the ends, they being 29 in. from the previous span. They were set a trifle above grade in order to allow settling during concreting.

ARCHES—In depositing the concrete in the arch ring, tracks were laid above the forms high enough to be used for placing the concrete in the spandrels. These tracks were laid on beams extending entirely across the bridge, the mixer for the concrete being at one end of the bridge. The concrete from the mixer was delivered in iron tipping cars, which were pushed over the track by hand, tipped and the concrete thus deposited in the arch ring, where it was well spaded. While one car of concrete was being unloaded a second one was being loaded at the mixer. The first three arch rings were poured with the mixer at the west abutment, the plant then reversed and the fourth ring poured from the east abutment.

Reinforcing rods for the arches were anchored at the abutment and piers to stub bars, which had been placed in the concrete foundation at the time of the construction of the piers and abutments. The rods were held at a uniform distance from the forms by small pieces of plate bent so as to have a Z cross-section, and notched at one end so as to receive the rods. The upper sets of rods were anchored to the stub bars before mentioned at the abutment, and at the piers they were extended into the next arch ring. They were kept at the required distance from the forms by means of riser pieces of ⅞-in. board which were removed as the concreting progressed. This set was also stiffened by means of transverse rods spaced 2 ft. c. to c. Tying the upper to the lower set were ½-in. round rods.

The specifications provided that the entire arch ring of each span should be poured in one operation in order that a monolithic mass would be had for this part of the bridge. The piers and abutments were finished up to the springing line before pouring the arch rings. The first or west-arch ring was poured Sept. 16, the time consumed being 15 hours, in which 150 cu.yd. of concrete were placed in position. As this was the first arch ring poured, it was not as rapidly or economically handled as the succeeding arches. The second arch ring was poured on Sept. 23 in 11½ hours, 135 cu.yd. of concrete being deposited. The third arch ring was poured on Oct. 3 in 13 hours, 135 cu.yd. being deposited, and the fourth arch ring, containing 150 cu.yd., in 11 hours. The force was the same each time and consisted of 26 laborers, one foreman, one superintendent and one engineer. One man, at all times when the arches were being poured, had the forms under observation to note any settlement. The maximum settlement at any time was about ½ in.

The forms for the spandrel walls were built on the arch rings, and all walls were poured from the same track as used for the arch ring. The concrete in the foundation consisted of 1:3:6 mix and for the superstructure 1:2:4 mix. For all the heavier parts of the work limestone screenings were used in the mortar.

but for the exposed surfaces and for the walls torpedo sand was specified, as it will bear greater rubbing and thus form a better surface.

EXPANSION — Expansion joints were formed over each pier by leaving out a 4-ft. space in which a pilaster was afterward inserted. The joints for the wall proper and the two copings were all approximately in the same vertical plane.

FINISH—Three sets of arch centers were used for the four spans, as it was not deemed safe to remove any set of centers until the concrete had been allowed to set for at least three weeks. After this time, however, the wedges were removed and the centers forced down from the lagging and floated away. The lagging is general stripped clean of concrete and there was little pitting or porous surface. Before pouring the concrete, all forms were thoroughly coated with linseed oil.

Before the arches were backfilled the extrados and walls were covered with a priming coat of asphaltic waterproofing applied with street brooms. On top of this was then applied a layer of hot asphaltum. This waterproofing was carried up to a point just above the surface of the finished paving.

All exposed surfaces of the wall were rubbed with a carborundum brick and a wash of neat cement then applied. After several days the walls were again rubbed, the whole resulting in a smooth, white surface, very attractive in appearance. The face of the arch ring, however, was finished with an ordinary brush finish, setting it off from the rest of the wall and relieving the monotony of the concrete surface.

The railing consisted of 8x8-in. concrete posts set in a concrete curb or lower coping and topped with a coping. The posts themselves were made on the ground separately, and from each end projected from 3 to 6 in. of twisted-steel rods, which were set into the lower coping in fresh mortar. The upper coping was built on the posts themselves. Over the piers and at the end of the rails were placed 12-in. concrete spheres which were bush-hammered after they had been placed.

After the railing had been in place for some time, it was noticed that a very considerable amount of white efflorescence appeared on the surface of the posts. These posts had been made with an exceedingly dry mixture, using the river water. The rest of the concrete had been mixed with the water furnished by the village of Riverside, which is very hard. The river water is comparatively soft. No efflorescence appeared at any place except on these posts, and it was noted that it was during the exceedingly damp weather which prevailed during the latter part of September and into October that it became very apparent. The river water is highly polluted by sewage, and is very foul in the late summer and fall. It is not impossible, though no analysis of the water used was made, that this water, carrying a high content of salts, such as sodium, magnesium, etc., which are generally found in sewage, was responsible for the efflorescence. The cement used had been carefully tested and contains no unusual amount of sulphides. This efflorescence, however, was removed by washing the posts with a very weak solution of hydrochloric acid, and it has not again become evident.

A tar-macadam pavement, using two gallons to the square yard, was constructed over the bridge. The pavement consisted of a layer of crushed limestone averaging about 8 in. in thickness, thoroughly rolled and bonded. On top of this was placed a second layer of somewhat smaller stone which was rolled dry, and on this 2 gal. per sq.yd. of "tarvia" was poured, filling the interstices of the stone. Following this a layer of limestone chips was rolled in.

When completed the bridge constituted a very attractive piece of engineering construction, the structure having strong simple lines without "gingerbread" ornamentation, such as is too often placed on this class of bridges. The contractor for the work was the Joliet Steel Construction Co., of Joliet, Ill. The designing and supervising engineer was the Aetna Engineering Bureau, of Chicago. R. A. Walther was the resident engineer.

The work, while presenting no unusual features, was rapidly and efficiently constructed, the new bridge being thrown open to traffic 90 days after construction started, certainly a short time to build a reinforced-concrete bridge 250 ft. in length.

THE INSPECTION OF CONCRETE WORK

A few points for an inspector to watch closely in reinforced-concrete work of this kind might be mentioned, as follows:

(1) The water used in mixing concrete should always be clean. This is generally mentioned in the specifications, but is often ignored by the contractor. The effect of bad water in the construction described here was shown on the posts.

(2) In general a wet mix is desirable, in order to make concrete with a minimum of voids. The tendency of the contractor is to make it much too wet, the cement then being washed to the lowest point of the forms, and the rest of the concrete suffering in consequence.

(3) Especial care should be taken to thoroughly spade the concrete against the forms, in order to prevent pitting. This class of work should be classified as requiring skilled labor, but too often it is slighted and reliance placed on plastering the concrete afterward.

(4) When the reinforcing bars required are very long the individual bars must be spliced. The lap should be great enough to develop the strength of the steel, or at least 50 diameters. Contractors are wont to ignore this provision of the specifications and reduce the lap to about 20 diameters, thus affecting a saving in steel.

(5) The sacks of cement should be counted each day and computations made to see that the proper amount of cement has been used. This should be done in addition to watching the mix itself. The cement sacks are generally tied up in bundles of 100, but too much dependence should not be placed on this and the bundles alone counted. Batches of sacks have been known to run 80 or 90 to the bundle.

(6) The amount of the reinforcing, that is, the area and number of bars used, should be frequently checked to see that the plan is followed. In a section having 50 bars, it is very easy to leave out half a dozen. The spacing also should be carefully followed.

(7) Look out for dirty, soft stone and sand and for lack of uniformity in the product of the mixers.

(8) There is no legitimate objection to the use of limestone screenings for making mortar, if the same rigid standard is maintained for them as is generally demanded of sand. Floury, powdery and dirty screenings should be at once condemned. There is as much variation in the quality of limestone screenings as in sand.

STATE SUPERVISION OF BRIDGES

There has been a considerable discussion, pro and con, as to the work done by consulting engineers on county highway bridges. The writer has designed and supervised as a consulting engineer about 25 country highway bridges, mostly in Illinois, and has some decided ideas on the subject, which may be summarized as follows:

(1) All country highway bridges should be built under the supervision of a state engineer, having full authority and ample powers by law. One reason for this is that the consulting engineer has little authority when employed by the township. In fact, the contractor often ignores him and deals directly with the highway commissioners. Under the present system an engineer is rarely employed for anything except to make the plans, and very meager plans are desired.

(2) Almost always, under the present system, both contractor and engineer are forced to be politicians, and much of the work is actually the result of promotion by the contractor.

(3) Most highway commissioners have little conception of an engineer or his duties, and if they employ one it is as likely as not to be the contractor who is bidding on the work.

(4) The contractor, as a rule, is much superior, mentally, to the men under whom he works.

(5) Under the present system, in Illinois at least, competition is practically strangled.

(6) Only a strong central authority can hope to cope with such a situation.

(7) The supervision of the state should only apply to the country districts, and not to incorporated cities and towns.

Oil-Fire Extinguishers for Naval Vessels

By Henry Williams

The adoption of oil fuel for naval vessels has introduced an element of considerable danger from fire. Due to leakage, which it is practically impossible to prevent, from manholes, pipe connections, pumps and seams in tanks, oil collects in the bilges of the firerooms. The surfaces with which it comes in contact remain coated with a film of oil, which burns freely when ignited or heated, communicating the fire to any oil that may be exposed. This constitutes a danger and already there have been several fires which fortunately have not resulted in serious danger to the ships, though all of them presented that possibility.

The extinction of such fires, once they have gained headway, is difficult. Water has no effect, as the burning oil simply floats on the surface of the water. Sand is more effective, acting to smother the fire. It must cover, however, the entire surface that is burning, and as it does not flow, must be applied locally. This is difficult for portions of the bilges under boilers or other obstructions, and the use of sand thus does not offer an entirely satisfactory guarantee against oil fires.

Recognition of these circumstances led the Bureau of Construction and Repair of the Navy Department over a year ago to undertake experiments looking to the development of suitable fire-extinguishing appliances to meet the possibility of such fires and to insure their prompt extinction. A board was appointed to investigate the subject and to undertake the necessary experiments to determine the suitability of the various systems.

The most promising methods that presented themselves to the board were those whereby advantage is taken of a heavy foam mixture which, when applied to burning surfaces of oil, flows over them and smothers the flame by shutting off its air supply. These foam mixtures have been tested extensively abroad, especially in Germany, and have given results uniformly satisfactory. A striking demonstration was made for the board at the plant of the Standard Oil Co., at Bayonne, N. J. A tank about 16 ft. long and about 4 ft. wide was filled to a depth of 5 in. with naphtha and ignited by an electric spark. The flame rising to a height of 20 ft. was extinguished in a few minutes by the foam mixture, which formed a blanket over the burning surface.

This foam is produced by the combination of two liquids, which are kept in tanks connected by piping to a mixing chamber. Here the foamy mixture is formed when the liquids are brought together, and sufficient pressure is generated by the chemical action to force the foam out. The volume of foamy mixture generated is about seven or eight times as great as that of the constituent liquids.

Portable extinguishers were designed similar in shape and sizes to the chemical fire extinguishers seen in buildings on shore. These have the liquids in separate compartments and by inverting the extinguisher the foam mixture is obtained and sufficient force generated to throw the foam a distance of about 20 ft. Two extinguishers of this type are supplied in each fireroom of oil-burning vessels. The question is under consideration of making stationary installations of greater capacity in the firerooms of oil-burning torpedo boat destroyers, and experimental installations of this character are being made.

It is by no means sure, however, that this system of extinguishing oil fires will prove a success on shipboard, though it may be accepted that its efficiency for shore purposes has been demonstrated beyond doubt. One of the most important difficulties that may be encountered is the possible effect on the crew of the carbon-dioxide gas given off by the foamy mixture. Ten per cent. of this gas in air has been known to prove fatal, and continued breathing of 2 per cent. is dangerous. In closed spaces, such as firerooms, where fires are apt to occur, especial care will need to be taken to prevent accumulation of this gas when the apparatus has been used.

Another difficulty and one that may render the system ineffective when needed is the liability to deterioration of the mixtures or the loss by evaporation of the water in which the solutions are made.

The corrosive action of the acid mixture on the containers and piping has been met in shore installations by leadlining them. The excessive weight required, however, is an obstacle to this means being adopted for shipboard installations, and in those now being fitted up reliance is placed on acid-resisting paint to prevent corrosion. It seems probable that this will not prove adequate and that corrosion of the tanks and piping will take place, and that such valves as are used will be rendered ineffective in a short time.

The formulas for the mixtures are as follows:

LIQUID No. 1

	Parts by weight
Glue	1
Glucose	½
Soda bicarbonate	7½
Salicylic acid	¼
Water	100

LIQUID No. 2

	Parts by weight
Aluminum sulphate	10
Sulphuric acid	½
Water	100

Carbon-dioxide gas is generated by the mixture of the soda bicarbonate and aluminum sulphate. The glue renders the liquid viscous and causes it to produce the foam. The salicylic acid is added as a preservative for the glucose, which is intended as a stabilizer to prevent the too sudden precipitation of the aluminum by hydroxide. The sulphuric acid aids in starting the reaction and acts also as a stabilizer. It is possible that it may be found that the acid itself can be omitted and in such an event the corrosive effect of the mixture on the container and piping will be reduced considerably.

The Design of Prony Brakes is discussed by F. A. Halsey in the Apr. 4 issue of the "American Machinist." He gives data on two brakes, showing the maximum power they would absorb without being disabled by the burning of the brake blocks. In the case of one brake, the maximum power absorbed was 200 hp., and the ratio of drum surface to horsepower was 0.0838 sq.ft. per hp. For the other brake the maximum power was 150 hp. and the ratio was 0.0872 sq.ft. per hp. Mr. Halsey proposes 0.09 as a limiting value of this ratio at which firing is imminent.

Mr. E. J. Armstrong, Chief Engineer of the Ball Engine Co., who furnished some of the data used by Mr. Halsey, believes that the thickness of the brake drum exerts some influence on its capacity. Since the brakes are water cooled, however, it is difficult to see in what way the thickness can exert any appreciable influence on the brake capacity.

The New City Hall for Oakland, Calif., is thus described by "The California Outlook" (Los Angeles, Mar. 23, 1912):

The design for this building may be said to consist of a low, wide base, fronting on an entire city block, serving as a platform, from which rises a large central shaft or tower, which is surmounted by a beautiful lantern of masonry, containing a clock with faces on four sides. It will be the highest building west of Chicago. The cornice of the main tower is 207 ft. above the sidewalk; the top of the lantern is 335 ft. 11 in., and the top of the flag pole more than 376 ft.

The interior of the building will be impressive in its beauty. The visitor enters by three low granite steps from the sidewalk on Washington St., and finds himself in a vaulted vestibule 66 ft. in height. From this point he can look directly into the central dome, 60 ft. in diameter, the crown of which is 125 ft. away and 80 ft. above the floor of the vestibule.

The Police Courts, Fire and Police Departments, the Mayor's suite of offices and the Commissioners' offices will be in the lower three stories. Above the fourth floor and to the 11th, inclusive, the administrative departments of the city will have their offices, and every conceivable accommodation has been arranged for these various departments. From the 12th to the 14th floors, inclusive, is the novel feature of the city prison and its emergency hospital.

*Naval Constructor, U. S. N., Navy Yard, Brooklyn, N. Y.

Concrete Mattress Bank Protection

By B. Okazaki*

On the Yubari River, in Japan, an experimental length of a mattress made of concrete blocks tied together with wire has proved very successful. The blocks, 6x6x24 in. in size, are cast on shore in large numbers, knitted together on a floating pontoon, and slid into place on the bank. The mattress has shown itself to be very flexible and admirably adapted for the conditions for which it was designed.

*Chief Engineer, Ishikari River Improvement Works, Sapporo, Japan.

About four years ago the writer devised a type of reinforced-concrete mattress for river-bank protection to supplant the ordinary fascine type which had been used extensively in Japan. In 1909 a section of the new mattress was placed on the Yubari River and its behavior there has been carefully watched during two seasons. As a result of that test the writer believes his reinforced-concrete mattress to be the most economical, durable, flexible, and altogether effective bank protection and that it is particularly adapted for the protection of those river banks where caving is most severe and where the now prevailing log mattress cannot keep its stability when forced to take a steep slope.

Description of Mattress

The main body of the mattress consists of reinforced-concrete blocks of suitable size knitted together by passing metallic wire of the proper diameter through two holes previously made in the middle plane of each block, thus forming a flexible stone mattress, each block being so set as to break joints. The width and length of the mattress may be made as desired by the use of a scaffolding device described below.

The chief advantages of the mattress are (1) its comparative cheapness, (2) its strength and durability, (3) the excellence of its adaptability to the deformation of the river bed on account of its flexibility, (4) its stability, even when forced to take a steep slope, (5) the small resistance it offers to the stream on account of its smoothness and thinness, causing no considerable contraction of the section and (6) the simplicity of its construction and the ease of its setting.

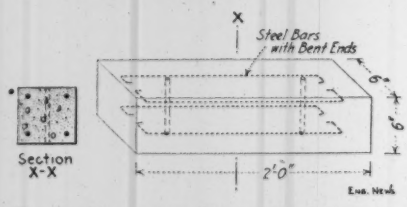


FIG. 1. DETAILS OF BLOCK USED IN REINFORCED-CONCRETE MATTRESS

Concrete Blocks—The thickness of the block may be determined by theoretical consideration, but in the work so far undertaken a 6-in. thickness has been used with a length of 2 ft. and a width of 6 in. The blocks are made of 1:3:6 portland cement, sand and gravel concrete, using, in the experimental work, both a wet and a dry mix.

Forms—In the experimental work metallic forms were used, so arranged that 40 blocks could be cast in each form. These forms were kept in a casting yard and the blocks cast in great quantities.

Reinforcement—The reinforcement of each block consisted of No. 12 galvanized steel wire somewhat shorter than the length of the block, with the ends bent as shown in Fig. 1. Four reinforcing bars for each block were inserted lengthwise. The object of the reinforcement is not only to strengthen the block, but also to prevent the splitting off in separate pieces of a block when a crack occurs.

Arrangement of Blocks—The blocks are arranged when in place as shown in Fig. 2. The string or wire for knitting together the separate blocks is a No. 4 galvanized steel wire for fresh water. It is better to use one long continuous wire bent double, as shown in Fig. 2, to avoid the joints of the wire as far as possible. Upon these wires the blocks are strung successively from the bottom to the top of the bank and when the last block has been placed the upper ends of each wire are tied together. In the lower end of the mattress there is a waling piece made up of a flat-steel bar 6 to 10 ft. long, 1⅛ in. wide and ⅜ in. thick. In salt water this bar may be changed to copper or aluminum. The adjoining pieces are joined by overlapping the ends so as to bring into coincidence the holes made for the wire near the ends of the blocks. The object of the waling piece is to serve as the form for spacing the blocks and also to protect the blocks against the shock of the drift, thus distributing the pressure over wide area. It undoubtedly also adds to the tensile strength of the mattress. In constructing the mattress the waling pieces are first placed and the wires strung through them, then the successive blocks strung, as shown in Fig. 2, using a special long block at either end so as to bring the broken joints even at the end.

Scaffolding—Two scaffolds were designed for the experimental work, both different from the usual pontoon stage which is used in American fascine-mattress work. These pontoon stages, which are inclined decks set on pontoons from which the mattress is slid off, cannot be used in this reinforced-concrete work, as it is highly desirable that the latter mattress be constructed in one continuous length several thousand feet long. The first type of scaffolding used in Japan is called the "free log scaffold," consisting mainly of slender logs of suitable length spaced 1 ft. apart and tied at their upper extremities to a horizontal waling log which is supported by stakes temporarily driven into the bank. The lengths of the logs composing the main part of the scaffold are so fixed that, when sunk, their lower extremities will reach the river bottom where the lower end of the mattress is intended to be located when set. In this type of scaffold the lower extremities of the logs are free. The type can be used in water up to 15 ft. in depth. A series of parallel rows of logs spaced 1 ft. apart furnish a stage with some inclination toward the river on which the mattress may be finished and from which it can be sunk as its construction progresses.

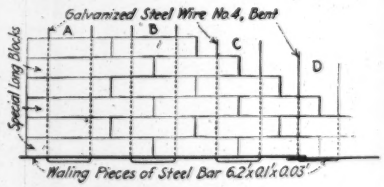


FIG. 2. METHOD OF JOINING BLOCKS TO FORM MATTRESS

The second type of scaffold is called the "pontoon-hung log scaffold" and is substantially a scaffold of the "free-log" type hung at its lower extremity to several pairs of pontoons. This type furnishes a scaffold of small slope on which the mattress may be knitted, the scaffold itself being suspended on the river side from the center of a pair of pontoons fastened side by side to a waling log supported on the stakes driven on the bank. Fig. 3 shows a scaffolding of this type in operation on the Yubari River. As soon as a suitable length of the mattress is knitted completely on this scaffold the suspension ropes are gradually let loose on board the pontoon until the lower end of the mattress reaches the river bottom. The ropes of suspension are then taken away so as to let the front pontoons free. This pair are then let loose and towed around to the rear posi-

tion in the fleet of pontoons, to be continued in the same use. The length of the fleet of pontoons working at a time varies according to circumstances. This type of scaffold is very suitable for work in more than 15 ft. of water.

TREATMENT OF RIVER BANK—The natural bank on and in front of which the mattress is to be set is at first graded to a proper slope above the low-water line and the excavated material thrown into the water directly in front of the excavated bank. Thus the portion of the bank below the low-water line is covered irregularly with loose material excavated from the upper part of the bank and the mattress is set on such irregularly formed bottom subject to further scouring and settling down. The greatest slope of the bank above the upper margin of the mattress is then covered with bank protection of various types. In the experimental work described below it was covered with 5-in. riprap laid on a graded slope within 3-ft. square panels surrounded by willow-twig fences knitted to small stakes driven on the bank. This is shown in Fig. 4.

FIG. 3. VIEW OF PONTOON-HUNG SCAFFOLD USED ON YUBARI RIVER IN SINKING REINFORCED-CONCRETE MATTRESS

EXPERIMENTAL MATTRESS

The experimental mattress was placed on a portion of the Yubari River, a tributary of the Ishikari River. The natural tendency of the stream at this point was to make a short cut by overflowing the narrow neck of land at a pronounced curve in the river. It developed here a much stronger current than in its main channel and severely attacked the naturally concave bank, which was an alluvial formation of great depth containing gravel up to 10 in. in diameter. It was feared that the new course the river might take would endanger the approach spans of an adjacent bridge. It may be said in passing that the protection has succeeded admirably in defending the bank at this point and no danger to the bridge is anticipated.

TOPICS OF INVESTIGATION—Considered as a matter of experimental nature, the topics of investigation were as follows: (1) the degree of the flexibility or adaptability of the concrete mattress to the deformation of the river bed occurring after the execution of the mattress when set with its upper edge fixed; (2) the translation of the mattress when set free at first and the extent of scour of the river bed after the execution of the mattress; (3) the proper width of the mattress; (4) the continuity of its length; (5) its resistance against the cold; (6) its resistance to shocks of ice and driftwood; (7) the best method of setting the mattress; (8) the cost, and (9) precautions necessary before setting the mattress.

RESULTS OF INVESTIGATION—As was expected, the scouring of the river bed was severe in front of the mattress work after its execution, but the mattress soon settled down and adapted itself to the form of the newly scoured river bed, showing not much rigidity against deformation. This adaptability of the mattress is shown clearly even to the naked eye when the stream falls and water is clear. The flexibility of the mattress being complete, there is much irregularity of its shape, since the scouring of the river bed goes on very irregularly after the natural agency and the mattress fits snugly to the newly formed irregular shape of the river bottom. This irregular flexibility is one of the main objects aimed at by the mattress. Flexibility does not mean the deficiency of strength in the mattress; it is as strong as it is flexible.

The above is the case for the portion of the mattress set with its upper edge fastened so as to check its dislocation as a whole, but allowing its lower portion to settle and suit the river bed as it deforms by the scouring. There is not a least doubt about the flexibility of the mattress. The state of change or settlement of the mattress is shown clearly in the cross-sections Nos. 25, 26, 27 and 28, in the accompanying Fig. 5.

When the mattress is set free with no fastening anywhere or, in other words, simply laid on the slope of the bank, so that it may slide down as a whole along the river bank if the river bottom and the bank are attacked severely by the scouring action of the river, the state of change or deformation is somewhat different from the case when the mattress is set fastened at its upper edge. In the portion of the river where the mattress work has been tried there was an increase of depth due to the scouring, in the majority of cross-sections of the river channel, though in some of them the reverse or decrease of depth was found to occur, as is shown in the table below, which was compiled from the results of a survey made for the purpose of ascertaining the change in the cross-sections one year after the execution of the mattress.

BOTTOM SCOUR, IN FEET, ONE YEAR AFTER CONSTRUCTION		
Section A,	2.28	Thalweg at the foot of the bank.
Section B,	3.86	Thalweg at the foot of the bank.
Section C,	0.89	Thalweg at the foot of the bank.
Section D,	0.85	Thalweg at the foot of the bank.
Section E,	1.82	Thalweg at the foot of the bank.

As the scour has increased the depth of channel as much as 3.86 ft., the dislocation as a whole of a portion of the mattress set free was observed, the maximum horizontal translation of the upper edge of the mattress amounting to 1.8 ft., while the maximum vertical translation amounted to 0.8 ft. In this location the mattress was deformed as well moved onward and downward so as to fit into the new form of the river bed. This dislocation is what was expected by at first setting the mattress free so that it might follow the scoured bed.

The worst case to be feared is that the dislocation of the mattress, when set free, might cause its upper portion to overturn upon its lower portion. This fear was not realized in the experimental work.

In the larger part of the site of the experimental work the width of 12 ft. for the mattress was tried so as to determine experimentally the minimum width of the mattress. The upper edge of the mattress was put at about 3 ft. above the ordinary low-water level. It was ex-

pected that this 12-ft. portion of the mattress would require further extension of its width when threatened by the scouring of the river bed after its execution. The change of the river bed has taken place as is shown by the results of surveying after the spring flood in the next year of its execution (Fig. 5). As was expected, the results of scour seem to demand the minimum width of about 15 ft., as in some portions of the 12 ft. mattress it has become already steep enough so that no further scour is welcome, while in the portion of the mattress having 15 ft. width the inclination of the latter is still so gentle as to be susceptible of further scour.

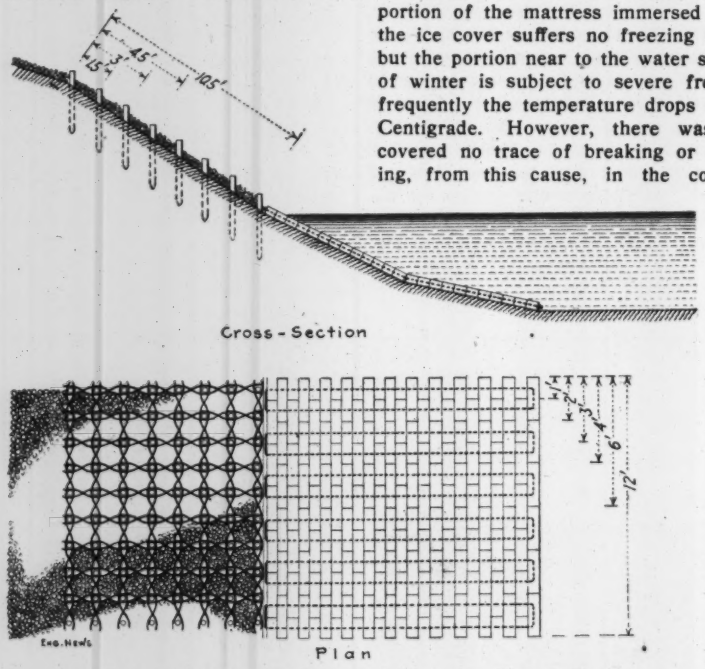


FIG. 4. DETAILS OF MATTRESS USED ON YUBARI RIVER

The total length of the experimental work is 600 ft. The best way is to make the total length of the mattress one continuous piece, since a joint would be the most dangerous point for the upstream end of the downstream piece to be caught by the drifts and lifted out of place. In the experimental work the different lengths of 456 ft., 72 ft., 54 ft. and 18 ft. were tried, at the same time taking the precaution to cover the upstream end of the downstream piece by the downstream end of the upstream piece, thus always providing an overlap of at least 3 ft., so as to lessen the risk of the ends to be caught and lifted up by the drifts. This method of overlapping has prevented damage from the joint between the two pieces and the different lengths show no particular difference as to deformation and settlement. Since the method of setting the mattress allows the construction of any long continuous mattress with no difficulty at all, there is no necessity to put the mattress in different pieces. Considered from the point of economy, the joint should be dispensed with as far as possible, as an extra expense is necessary for overlapping the adjoining pieces.

In this climate the river surface is covered with ice and snow during winter to a thickness of from 1 to 3 ft., but the portion of the mattress immersed below the ice cover suffers no freezing action, but the portion near to the water surface of winter is subject to severe frost, as frequently the temperature drops to 20° Centigrade. However, there was discovered no trace of breaking or cracking, from this cause, in the concrete blocks used as the main material of the mattress work.

As to the shocks of ice and driftwood the mattress met with plenty of driftwood as large as 30 ft. long and 2 ft. thick, and ice as many feet long, 1 ft. thick and 20 ft. wide, but suffered no particular damage from these sources of destructive agencies.

After grading the bank above the low-water surface in setting the mattress, a "free log scaffold," with some inclination toward the river was used to knit the mattress; it was sunk bit by bit as the knitting went on, letting the finished part slide down along the inclined surface of the scaffold made of logs some 18 to 20 ft. long and 4 in. thick, placed 1 ft. apart. With this scaffold the setting of the mattress was done very easily and some length of the mattress was set even during the flood of medium height without interruption.

The actual cost of the mattress is 3 Yen ($1.50) per sq.yd. in the experimental work, but in the later work of the Ishikari River improvement work the cost of the mattress has been reduced to 2 Yen ($1) per yd., owing to the employment of the skilled labor and the slight improvement made on the apparatus and yard arrangement. This is cheaper than the prevailing log mattress, but more economy is expected in the future work.

The engineers were ignorant of small snags lying on the foot of the river bank where the mattress was set. When the stream subsided it was found that the mattress in such portions was overriding the snags, inducing to anchor there other snags. As this will cause great damage to the mattress and the bank the engineers were obliged to remove the snags.

CONCLUSIONS

From the foregoing we may conclude that it is necessary to clear the portion of river bed to be covered with the mattress of any snags before setting the mattress, for the mattress when mislaid, overriding the snags, may cause other snags to catch and thus induce great damage to it and the river bed, as it leaves an open space between the river bed and the mattress. Further, the mattress should be set at first with the minimum width and with its upper edge far above the low-water level, either fastened or entirely free, exposing the upper portion to the action of severe frost, taking precaution to set the mattress in a continuous sheet, if possible, and to overlap the upper end of the downstream section by the lower end of the upstream section when the division of length in sections is unavoidable. The cost of the mattress is expected to be reduced by the employment of expert labor and the perfection of apparatus and yard arrangement.

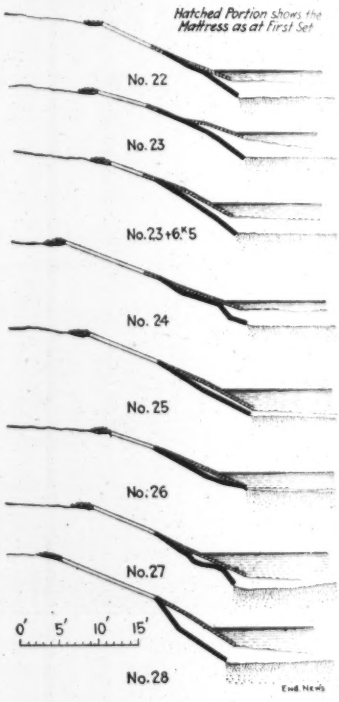


FIG. 5. SECTIONS OF CONCRETE MATTRESS ON YUBARI RIVER
(Showing positions taken by mattress after one year's use.)

An Accident to the Paving of Owl Creek Dam, Belle Fourche Irrigation Project, South Dakota

The paving on the water side of the Owl Creek dam, a part of the Belle Fourche project of the U. S. Reclamation Service in South Dakota, was recently damaged by waves caused by a high wind acting upon the water in the reservoir. The dam is paved with large concrete blocks lying on a slope of 2 on 1. Some 250 of these were displaced on the night of the storm, entailing an expense of about $5000 for repairs.

This dam is built across the valley of Owl Creek, a tributary of the Belle Fourche River, near Belle Fourche, S. D. It is one of the largest earth dams ever built, having a length of 6500 ft. and a maximum height of 115 ft. It contains some 1,600,000 cu.yd. of material and forms a reservoir with a storage capacity of 215,000 acre-ft., or 70,000,000,000 gal. A full description was published in ENGINEERING NEWS, Feb. 22, 1906, p. 210.

The nature of the accident and the means adopted for preventing its repetition are described in a report to the director of the Reclamation Service by Chief Engineer Arthur P. Davis, of Washington, D. C., from which the following account has been abstracted:

On the night of Apr. 13, when water in the Belle Fourche reservoir stood at elevation 2959, a very high wind from the west caused waves in the reservoir 8 or 10 ft. in height which beat against the concreted slope of the dam. This attack from without was successfully resisted, but at the culmination of the storm, which occurred between midnight and 4 a.m. on Apr. 14, the receding waves periodically relieved the weight on the concrete blocks so that the back pressure of the water behind the pavement displaced a considerable number of blocks in the 17th course. The upper edge of this course is at elevation 2958. The displacement of these blocks permitted the waves to act upon their gravel foundations, and gradually undermined the blocks above as far up the slope as the waves could act, viz., at some points to elevation 2973, allowing them to settle down against the clay slope, forming an irregular pavement.

In all about 250 blocks, out of the total of 16,000 forming the pavement of the dam, were displaced, and a few others will have to be removed in the process of repair. The total gravel removed is probably 500 or 600 cu.yd., and only a small quantity of clay was missed, as this resisted erosion remarkably well.

The wind that caused the initial displacement of blocks was estimated by the project engineer to be blowing at the rate of about 70 miles per hour, but this is uncertain as no actual observations of the rate were made at this point. The only actual data available are the anemometer observations taken once a day at the experimental farm on the project about 12 miles east of the dam, which showed the mean wind velocity for the 24 hours preceding 7:30 a.m., Apr. 14, as 24.6 miles. On the same night, velocities were reported in Denver as high as 75 miles per hour, and considerable damage was reported on concrete paving of dams.

Our examination leaves no doubt that the damage was caused by the forces above described. The joints in the pavement varied from a very fine crack to a few nearly 1 in. wide, most of them being less than ½ in., and the average about ⅓ in. The blocks are 6½ ft. long, 5 ft. wide and 8 in. thick, and lie on a slope of 2 to 1, in horizontal courses with vertical joints broken. On the clay slope of the embankment was laid first 12 in. of "run-of-pit" gravel and sand in approximately equal parts, and on this was laid 12 in. of screened gravel, held on a ¼-in. mesh. This was wetted and rolled and the blocks were placed upon it, making a smooth pavement.

The water at all times stood in the gravel against the clay under the concrete blocks, at about the same height as the general level of the water in the open reservoir. The sudden recession of the high waves removed the water pressure from the outside of the blocks, leaving a hydrostatic pressure behind equal to the difference between the trough of the wave and the mean level of the reservoir. In this storm, the head thus produced probably reached 4 or 5 ft., producing a force more than double the weight of the block. This was partly relieved by the cracks in the pavement and resisted by the friction of adjacent blocks, but where these were insufficient the block was lifted from place and allowed the waves to wash out the underlying gravel and to undermine the adjacent blocks.

The trough of the largest waves came about the bottom of the 17th course, so that the maximum back pressure was concentrated at this elevation. No breach was anywhere found that did not evidently originate in the removal of a block from the 17th course. Where irregularities of slope made this course about 1 ft. lower than in other places, no damage was done, the pressure being there divided between two courses.

It is plain that had adjacent courses been firmly fastened together, no damage would have occurred, and this suggests the obvious remedy, that of fastening each course to the ones above and below. In order to effect these repairs, the water was drawn down to the bottom of the 17th course at elevation 2955, leaving 78,000 acre-feet of water still in the reservoir, which will be sufficient for all storage needs during the present season. In order to prevent a recurrence of damage of a similar nature in the future, it is believed that the fastening together of the blocks, should be extended to that portion of the entire face of the dam subject to this danger. Ice will be on the reservoir in spring never lower than 2950 or about the upper edge of the 13th course, while high water at 2975 will submerge the top of the 24th course about 1 ft. Thus the courses from the 13th to 24th are within the danger zone and fastenings will have to be supplied for 12 courses.

The means of fastening which can now be best provided is in the form of galvanized-steel clamps about 1x1¼ in. in section, of a "U" form, the bent-over ends being let into holes drilled in the concrete blocks about 6 in. from the edge and firmly grouted. Four clamps are to be used in each slab where the waves are likely to be highest and two clamps, placed in staggered positions, where the attack is less severe. The details are to be left dependent upon certain drilling experiments already started. The total number of clamps will be about 9000. The drilling of 18,000 holes will involve considerable expense which cannot at present be closely estimated.

The Sewage of Glasgow, Scotland, is treated at three chemical precipitation works. The earliest of these, at Dalmarnock, treats an average daily flow of 22,000,000 U. S. gal. The sewage here is first passed through vertical screens and then through two catch pits from which the deposits are removed by mechanical means. After flowing from the catch pits to a pump pit the sewage is lifted by five centrifugal pumps to a chemical mixing pit at which point a precipitant is used. The sewage then goes to the settling tanks and from these the clarified effluent passes directly to the river. The sludge from the settling tanks is pumped to three storage tanks where after sedimentation about 50% of the upper part of the liquid can be drawn off. The remaining sludge is then raised by high-pressure rams to sludge presses. The total amount of wet sludge dealt with per year is abou 247,000 long tons. The second plant, built at Dalmuir, treats an average daily flow of 43,000,000 U. S. gal. The general method is like that used at Dalmarnock, except that the sludge is pumped to an elevated tank and flows from this by gravity into a 1200-long-ton sludge steamer. This steamer carries the sludge for a distance of 40 miles and dumps it at sea. The chemical precipitant used at Dalmuir is persulphate of iron and lime. The third and most recent plant, located at Shieldhall, treats an average daily flow of 27,600,000 U. S. gal., and it is like the Dalmuir plant. According to a paper which was read at the Institution of Civil Engineers, on Mar. 19, 1912, by A. B. McDonald and G. M. Taylor, and abstracted in the London "Contract Journal" of the following day, the precipitation process at the three works completely removes the solid matter from the sewage. As a result the condition of the River Clyde has been restored from one of considerable nuisance to what our contemporary terms "a live and satisfactory condition."

A Novel Factory Building

A new factory erected at Springfield, Mass., recently by the Bosch Magneto Co., for manufacturing its magnetos, spark plugs and other products, embodies several features that depart quite notably from conventional types. The framework of the building and also its foundation are of reinforced concrete, and in this are found several important novelties, both in arrangement and in detailed design. The ventilation and heating system of the factory, however, is even more unusual. In connection with the ventilation the window arrangement is of interest. Special features are also found in the lighting and in the power equipment of the building.

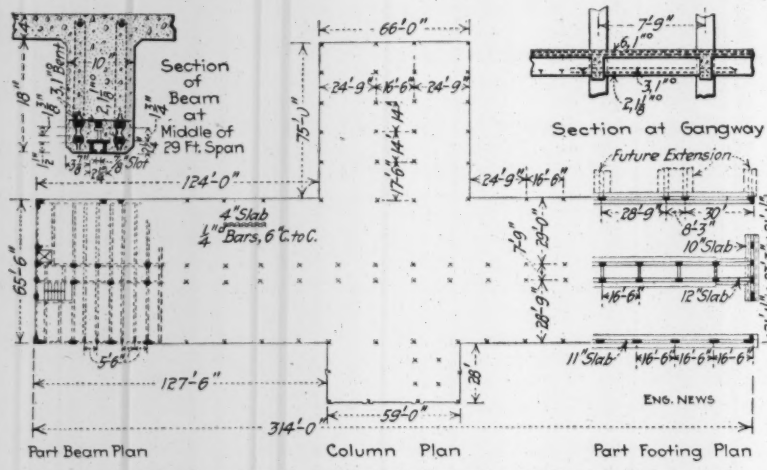


FIG. 1. SKETCH PLAN OF NEW FACTORY BUILDING OF BOSCH MAGNETO CO., SPRINGFIELD, MASS.

GENERAL ARRANGEMENT

The factory building as now constructed is a long rectangle 65½ ft. deep by 314 ft. long, with a central extension to the rear 66 ft. wide projecting 75 ft. back of the main structure, and a smaller front extension which contains the main entrance and stairway. It is planned for a force of 1000 workmen, or 300 per floor (stock rooms, etc., not counted). The plans for future development of the plant contemplate building a second structure exactly similar to the present one about 150 ft. back of the present main building and connecting the two at both ends and middle, the latter connection being made by lengthening the present rear extension. This will make a single building covering an area 314x260 ft., with two interior courts about 58x125 ft. each. The plan is that as soon as the present structure becomes inadequate, side wings will be built back from the main building, the rear main building being constructed last of all. The finally completed structure will accommodate 3000 employees.

The structure consists of four stories, each 13½ ft. high, but has no basement. There are several roof houses containing ventilators and air-cooling arrangements. The main stairway in the front extension is supplemented by emergency stairways at either end of the main building and elevators near each of the latter. The rear extension has no elevators or stairways, this being devoted wholly to wash and locker rooms.

From the shallow front wing containing the main stairs, on each floor, a passageway runs back through the main building to the washroom. The right and left halves of the main building are thus separated from each other. The passageway forms not only the main corridor, but also serves as main ventilating duct, as will appear later on.

Each half of the building is traversed by a longitudinal central bay which is the gangway leading to all parts of that half. This bay is only 6½ ft. wide in the clear. It divides the half building into two large rooms. Thus, a single floor of the building consists of four large workrooms, each 29x124 ft., which may, of course, be subdivided or arranged in any way that may be selected to suit the working routine.

STRUCTURAL ARRANGEMENT

FLOORS—The column arrangement is determined by the arrangement of the workrooms; all interior columns being set on the lines of the 6½-ft. gangway, the workroom floor areas are not broken by columns. The plan Fig. 1 shows this clearly, and illustrates how the floor framing as well as the foundations are individualized by this arrangement.

The main floor-girders extend along over the columns of the gangway and in the longitudinal walls (front and rear), with spans of 16½ ft. Beams run from front to rear, transverse to the line of these girders, at 5½-ft. spacing; each beam is built continuous over three spans (29 ft., 7¾ ft., 29 ft.), which reduces the bending moments in them. The floor is a reinforced-concrete slab 4 in. thick designed for factory loading, 200 lb. per sq.ft.

All floor reinforcement is made of corrugated bars and units made up of these bars ("Corrbar" units).

The beams are adapted to receive hangers for pipes, shafting or any other suspended load by molding in the bottom face a U-shaped cast-iron channel, as shown in a sectional sketch in Fig. 1. Tee-headed bolts may be inserted in the slot of this casting at any point for attachment.

FOUNDATIONS—Spread footings of slab-and-beam type are used. The central columns being near together, it was necessary to merge their footings, on account of the low loading which it was thought desirable to use in the soil encountered. The footings rest on a clay stratum, but a few feet down there are layers of fine water-bearing sand. The footing pressure was therefore kept down to 2500 lb. per sq.ft. The sketch Fig. 2 shows the type of construction used for the central-column foundation. The footing slab, 14 ft. wide in the narrow dimension of the building, receives its load from beams extending between the columns both transversely and longitudinally. The longitudinal beams, which have the most important load-distributing function and carry the largest shear, are shaped with enlarged ends to increase their shear area. It proved possible to concrete the sloping surfaces without cutting the side forms, as the stirrups retained the concrete sufficiently.

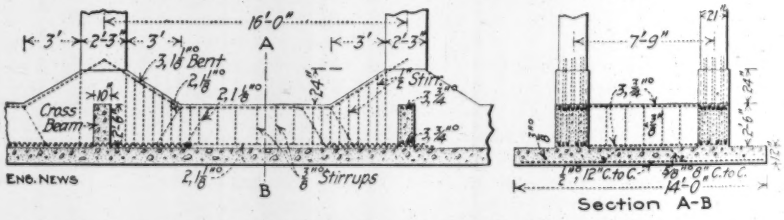


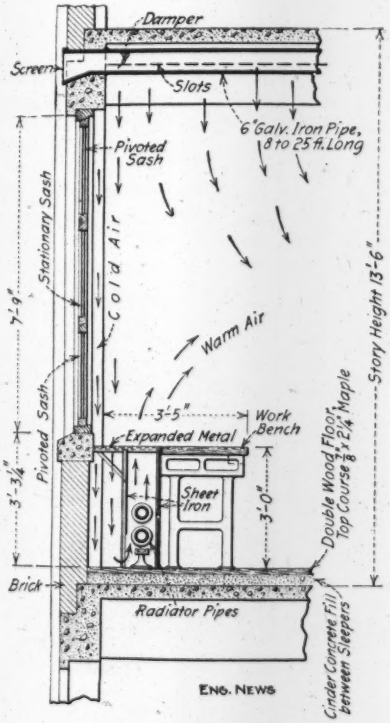
FIG. 2. FOUNDATION OF CENTRAL COLUMNS, BOSCH MAGNETO CO.'S FACTORY

EXTERIOR — The reinforced-concrete structure appears to some extent in the exterior of the building. The floor girder forms the window lintel of the story below. Above it a concrete window-sill is formed. The space between girder

and sill is filled by a curtain-wall of tapestry brick. Windows occupy 60% of the gross story height.

The roof, which is also of reinforced concrete, carries a cinder fill covered with five-ply felt-and-tar waterproofing surfaced with slag. The cinder fill has a maximum thickness of 18 in., being sloped for roof drainage.

SPECIAL RETAINING WALL—The boiler house is placed under ground just back of the main building in the area which under the completed plan would form one of the interior courts. Constructing this room in rather uncertain ground required the use of a special expedient to secure a safe foundation for the wall nearest the main building. The sketch Fig. 3 illustrates this. The wall is designed as a retaining wall of reinforced concrete, but the heel-slab which extends into the earth backing is not placed at the base of the wall, but 6 ft. up, thus reducing the difficulty of excavating at a short distance from the already completed foundation of the main building.



FIG, 4. CROSS-SECTION OF MAIN BUILDING AT WALL, SHOWING WINDOWS, WORKBENCH AND RADIATOR ARRANGEMENT, BOSCH MAGNETO CO. FACTORY

In laying the floor of this boiler house the groundwater gave some difficulty, as it stood above the level of the bottom of the excavation, and the bottom was fine sand. The floor concrete was therefore laid in water. This did not secure a perfect floor, but the concrete formed a sufficiently complete barrier to permit pumping out and then patching the remaining leaks. Therefore the 8-in. layer of concrete (reinforced) was surfaced with a 2-in. sheet of concrete and over this a 1-in. surface coat of waterproofed mortar. Similar waterproofed mortar was used for coating the inside surface of the walls of this boiler room. The roof is

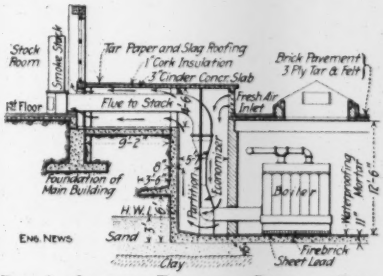


FIG. 3. SECTION THROUGH PART OF BOILER-ROOM, SHOWING SPECIAL RETAINING-WALL AND AUXILIARY HEATING WITH SMOKE-FLUE RADIATION; BOSCH MAGNETO CO. FACTORY

waterproofed with three-ply tar-and-felt on which rests the sand base of the brick courtyard pavement.

FINISH OF BUILDING

Except in wash and toilet rooms, where the floors are of concrete, the reinforced-concrete floor-slab has sleepers laid on it in cinder-concrete fill, and a double wood floor is laid on the sleepers; the upper course is 7/8x2¼-in. maple. Machinery is screwed direct to this wood floor, except that in case of the heavier machines it was necessary to give the machine base a firm bearing by drilling through to the cinder-concrete fill and forcing in cement grout.

The windows in the workrooms are arranged in three tiers, the middle one fixed and the upper and lower swinging (see Fig. 4). The windows are *double glazed*, glass being fitted in each side of the frame. The inner sheet is set in a separate hinged panel, to give access to the inside faces for cleaning. Details of the windows are shown in Fig. 5; the outer glass is factory-ribbed, the inner is clear. Worm-gear operating mechanism is provided for groups of the swing sash, and the opening of windows is out of control of the workmen.

The windows play an important part in the ventilating and heating scheme, as will be described.

HEATING AND VENTILATION

The building is heated by low-pressure steam, through radiators placed behind the workbenches below the windows, as shown by the section Fig. 4. Some additional heating is obtained by radiation from the boiler smokestack, which is inside the building, and by distributing hot air from a chamber surrounding the smoke flue (Fig. 3). The air in the economizer chamber supplies a considerable excess of heating over what was expected (one room of the ground floor), and in future some of it will be piped to other parts of the building.

The boilers, two in number, are sectional cast-iron boilers, each of 30-hp. capacity. The steam system is of the double-pipe type; the condensed water returns to the boilers by gravity. The radiators are of ribbed-pipe cast-iron horizontal sections.

The building is ventilated by exhausting air through the central corridor, the necessary draft being produced by exhaust fans in a ventilator house built on top of the main staircase bay. The corri-

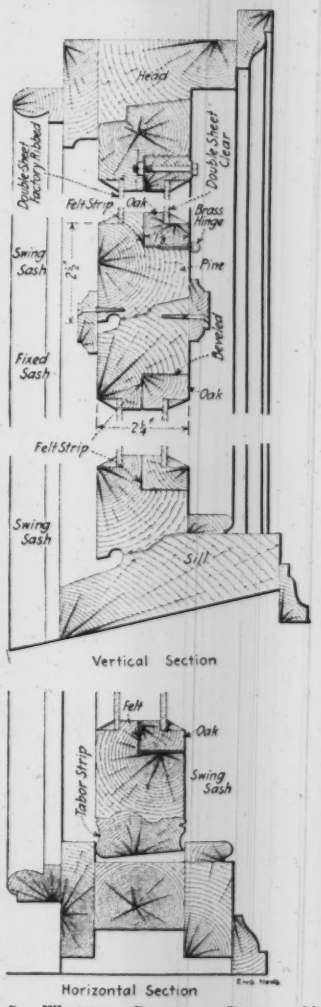


FIG. 5. WINDOW DETAILS, BOSCH MAGNETO CO. FACTORY

dor walls are fitted with louvers at top and bottom, either set of which can be opened to draw air from the workrooms.

The necessary inflow of air to make up for the air exhausted is furnished by a series of horizontal pipes extending

along under the ceiling transverse to the length of the building, from openings in the outside walls (Fig. 4). These pipes, 6 in. in diameter, are of galvanized iron. Those farthest from the central passage are longest (up to 25 ft.) and those nearer the passage are shorter, to a minimum of 8 ft. Longitudinal slots about

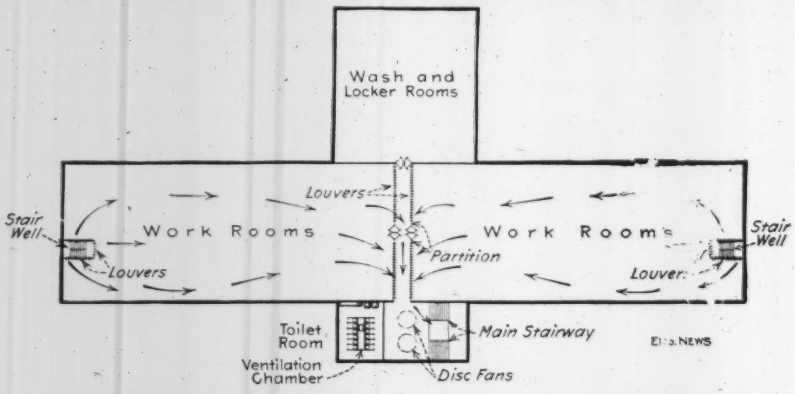


FIG. 6. DIAGRAM PLAN OF BOSCH MAGNETO CO. FACTORY, SHOWING AIR CIRCULATION UNDER SUMMER CONDITIONS, WITH AIR-COOLING PLANTS AND EXHAUSTERS WORKING

⅛ in. wide in the lower half of each pipe admit the outside air to the building. A damper is fitted in each pipe near its outer end to throttle or close off the air admission. Cold air falling in thin currents from the slots in the pipes passes through the warm air of the room, mixes with it, and follows the general draft toward the central corridor.

shown in Fig. 4. The air cooled along the window surface, together with air leaking in, passes down and enters the rear half of a compartment back of the workbench, screened on top by a sheet of expanded metal. From the bottom of this compartment it passes up the front half of the compartment, in which the radiators are placed, and thence up through the screen of expanded metal into the room as an upward current of heated air.

This arrangement was devised to protect the work people and benches from the chilling action of the outside wall, to remove the radiators from the direct influence of the walls (by the insulating effect of the outer compartment) and to do away with the uncomfortable effect of the downward flow of cold air along windows and wall and utilize it for distributing the heating effect.

During the past winter, when the factory was running to about half capacity, the heating system was in full operation and it is reported by the company to have worked very successfully.

The draft-producing plant and the ventilating system in general are proportioned to produce a complete change of air twice per hour normally, with a maximum capacity of eight changes per hour. When the main exhaust fans (normal capacity each 100,000 cu.ft. per min.) are supplemented by running the cooling house fans as exhausters, a ventilation up to 12 changes per hour can be obtained. It is not thought that this will be necessary except under unusual conditions.

The arrangements so far described are intended for use both in summer and in winter, with the exception that in winter the lower louvers of the corridor walls are opened and in summer the upper louvers. In hot weather, however, it is desired to cool the air below the temperature of the outside air, and the system as described would, while affording good ventilation, not add coolness in summer. Air-cooling plants have therefore been installed in roof houses over the two emergency stairways (at either end of each half of the building). Each of these roof houses contains a water-spray air-cooler and a blower of 30,000 cu.ft. per min. capacity, which draws the air through the cooler and discharges it through the emergency stair wells into the building. The water spray is supplied from the private well of the plant at a rate of about 60 gal. per min. for each machine at a temperature of 54° F. The air coolers are guaranteed to cool air containing 9.3 grains of moisture per cu.ft. from 95° to 78° F., and it is expected that the use of these machines with air supplied at the rate of four changes per hour will maintain a temperature in the building at least 9° below the outside temperature in summer.

The ventilating plant will help to cool the building in summer, by operating through the night with air-inlet pipes open, and drawing the cool night air through the rooms. Thus the structure

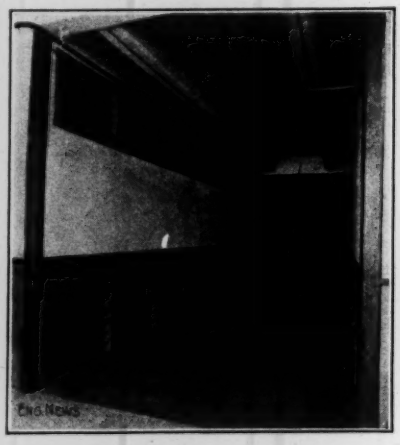


FIG. 8. TRANSVERSE CORRIDOR OF BOSCH MAGNETO CO. FACTORY, SHOWING VENTILATING LOUVERS TO WORK-ROOMS

FIG. 7. VIEW DOWN CENTRAL AISLE OF FACTORY FLOOR, SHOWING ATTACHMENT OF SHAFTING, PIPES, WIRE CONDUITS, ETC., TO BEAM SLOTS

This admission of outside air through these pipes is only part of the system, however. It is recognized that in spite of the double glazing and the special efforts to make the window-sash tight, considerable air leakage and air-cooling action occur at the windows, and this is utilized for the general heating, as

will be thoroughly cooled by morning. In daytime the air-inlet openings and the windows are to be closed, as the outside air is then hot, and air will be supplied through the coolers.

The cooling plant has not yet been tried out under summer conditions and its working cannot therefore be reported.

The ventilation of the toilet rooms in the main stairway extension is separate from the ventilation of the main building, although the main exhaust fans supply the draft by a branch pipe entering the main intake to the fans. In the toilet room on each floor the water-closets are arranged back to back, separated by a narrow chamber in which all the piping is arranged. Each bowl is vented into this chamber by an opening of 12 sq.in., and the chamber is ventilated through a vertical pipe ascending through the several toilet rooms and leading to the fan intake.

The wash and locker rooms in the rear extension are not provided with ventilation. The windows are relied upon to provide the necessary air change.

FIG. 9. VIEW IN WORK-ROOM OF BOSCH MAGNETO CO. FACTORY
(Note slotted air-inlet pipes at ceiling.)

OTHER EQUIPMENT

The plant draws its water supply from a well located on the rear of the property, but this water is used only for flushing, water spray in the air-cooling machine, elevator supply, etc., and not for drinking use or for fire-protection purposes. Drinking and fire-protection water are supplied from the city mains of Springfield and Chicopee. The factory building is located just on the town line between the two cities and both water systems were available for connection. These are high-pressure supplies, 110 and 140 lb., respectively, and therefore were excellent sources of supply for the fire piping. The building's water mains are connected to both systems, but the main valves on the branches from the two sets of mains are interlocked in such a way that only one valve can be opened at a time. A locking bar crossing the top of both valve stems is so arranged that before either valve can be opened the bar must be thrown across the other valve stem, holding it securely in closed position.

A Diesel engine of 280 hp. will supply electric power to the entire plant. This engine has not yet been operated, current for the present being taken from the local city electric supply. The jacket water of the engine will be used as hot-water supply to the wash rooms. The shop machines are driven in groups by electric motors, the main shafts being about 60 ft. long. The power system is two-phase four-wire 60-cycle 440-volt alternating current. Induction motors in sizes from 10 to 20 hp. are used.

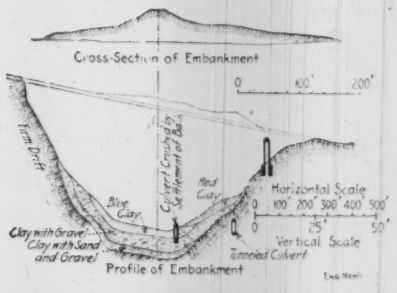
The lighting is provided generally by ceiling lamps, but in the case of specially fine work by individual lamps. The lamps are laid out for an illumination of 4.2 foot-candles in the office and 3.9 foot-candles in the shop. The lamps are generally 60-watt units, but where local lighting was necessary 40-watt units were used.

The building was constructed by Tucker & Vinton, Inc., of New York. It was designed by A. R. Klein, Consulting Engineer to the company, and C. M. Wild, Factory Manager. Somes & Parsons, Architects, of Boston, Mass., drew the elevations of the building.

The Production of Liquid Petroleum products from natural gas is discussed by I. C. Allen and G. A. Burrell in Technical Paper No. 10 of the U. S. Bureau of Mines recently issued. They show how the natural gas which is being allowed to escape in all the petroleum fields of the country may be put to use by the storage of liquefied products. The products are classified under four heads: (1) common natural gas, (2) semi-gas products, (3) light liquid products, (4) heavy liquid products. They believe there is a possibility of using the second product as a liquefied gas to be held in high-pressure steel tanks for use in small towns, hotels and country houses where there is not a possibility of an ordinary service connection. The authors believe that a mistake has been made heretofore in not regarding this liquefied product as a gas and not insuring the safety of the public in transportation. They find that in the general practice in the manufacture of liquid natural-gas products, single-stage compressors have been used and operated at a pressure of only 150 to 300 lb. per sq.in. The one product has been called a "natural gasoline," and out of it lighter portions were allowed to evaporate, wasting both valuable products and the energy of compression. The processes may be improved now by using multi-stage compression and separating the products of the different stages to yield the different groups noted.

Spreading of a Railway Embankment on Soft Clay

Railway embankments of considerable height resting on soft foundation layers frequently give trouble. A case of such trouble is illustrated by the sketch herewith, taken from the *Zentralblatt der Bauverwaltung*, of Jan. 3, 1912; it refers to an embankment on a new railway line in northern Switzerland (the Ricken Tunnel line, near St. Gallen). The embankment, 50 ft. in maximum height and about 1000 ft. long, crosses a valley which is in firm glacial drift but whose bottom was covered by subsequent stream deposit with a clay layer 12 to 15 ft. deep. This clay layer was too soft to support the weight of the embankment and the fill therefore spread, incidentally crushing a small arch culvert which had been built at the lowest point of the valley.



SECTION AND PROFILE OF RAILWAY EMBANKMENT WHICH SPREAD BY FAILURE OF CLAY SUBSOIL

To secure drainage through the embankment it was ultimately necessary to construct a new culvert in the undisturbed drift. The new culvert was located on the side hill, well beyond the clay deposit. Tunneling methods were required to put it through the embankment, the drift being lined with concrete as it went forward. The water which in the meantime had accumulated above the embankment had to be pumped over the embankment before connecting the tunnel.

When this was accomplished the embankment was built up with considerably flatter slopes, shaped after those to which the embankment had slumped. The cross-section shows the shape which resulted. The outcome was that about twice as much material was consumed in building the embankment as calculated originally, that is to say about 210,000 cu.yd. instead of 100,000. The embankment was finally carried up 5 ft. higher than the intended elevation of subgrade in order to subject the foundation to an overload, and when the work was ready for placing the roadbed and track this extra depth of fill was removed. No further spreading or slipping has been reported.

The Atlantic Coast Waterway

The project for an inland waterway parallel to the Atlantic Coast, from Boston to Beaufort Inlet, N. C., has been investigated by a Board of Engineers. The Southern links in the proposed waterway, through the sounds of North Carolina and the proposed purchase and deepening of the canal connecting Chesapeake and Delaware bays, are approved. The other parts of the project are not recommended.

Surveys were made for a ship canal at sea-level with 25 ft. depth of water extending across New Jersey from New York Bay to the Delaware River at Bordentown, and a remarkably advantageous route was found involving no rock excavation. While the amount of material to be excavated is about equal to that required for the Panama Canal, the favorable conditions make the total estimated cost only about $50,000,000 in round numbers. The project, however, is not approved.

As many of our readers are aware, agitation has been in progress for some years to secure the construction by the Federal Government of an inland waterway parallel to the Atlantic Coast, which should extend all the way from Boston to Florida. The idea of the promoters of this scheme is that there already exists a waterway more or less protected over considerable part of this distance, made up of Narragansett Bay, Long Island Sound and New York and Raritan Bays at the North and at the South the Chesapeake and Delaware Bays and the shallow sounds extending in a net work along the Southern coast. By building comparatively short lengths of canals, and by dredging in the various sounds, these several stretches of natural waterway could be connected to afford continuous passage for vessels.

At first sight, the proposed scheme seems on its face to be chimerical. Ocean transportation is well known to be cheaper on the whole than transportation on inland waterways. Why, then, should it be undertaken to build a ship canal at an enormous expense to parallel the open ocean? It is quite safe to say that no capitalist would invest in such an enterprise in the hope of receiving returns on his money in the shape of tolls on the traffic accommodated. And if it will not pay the private investor, why should the taxpayers be asked to furnish funds for the work?

The claims of the promoters in answer to this argument are that barge transportation, for cheap bulky materials at least, is less costly than transportation in regular ocean-going vessels. Barges for use in smooth, protected waters can be built at a very much less cost per ton of carrying capacity than ocean going vessels. A number of barges can be towed by a single large tug. For coal transportation along the Atlantic coast, towed barges have proved cheaper than vessels propelled by their own power. The barges now in operation between Norfolk and Northern ports have to be seaworthy enough to navigate the open ocean; but if an inland waterway were available all the way, still cheaper vessels could be used and the outlay for marine insurance would be reduced.

As a result of the various conventions held to boom the Atlantic deep waterway project, the River and Harbor appropriation bill, which became law March 3, 1909, contained an appropriation for a survey to be conducted under the direction of the army engineers for the construction of a deep waterway from Boston to Beaufort Inlet, N. C., "for the purpose of ascertaining the cost of a channel with a maximum depth of 25 ft. or such lesser depth along any section or sections of the said waterway as may be found to be sufficient for commercial, naval or military purposes."

It may be here remarked that the same bill contained also provision for surveys for inland waterways extending on down the Atlantic Coast to Key West, Fla., for a 12-ft. ship canal across Florida, for an inland waterway along the coast of the Gulf of Mexico from Florida to the Rio Grande River with a depth of 9 ft., and finally for an inland waterway in California between Humboldt Bay and Eel River.

Probably if the secrets of all hearts were revealed, it would be found that the real motive back of the agitation to build canals parallel to the ocean along the major part of our coast line was the accumulation of credit and political capital by the Congressmen resident in the various coast districts. These Congressmen had witnessed the success of their fellow members from inland districts in advertising themselves by booming "the Lakes to the Gulf deep waterway," and the collateral schemes for improving the Ohio, the Missouri and various other tributaries of the Mississippi.

Why should not the Congressmen from the coast districts also have a huge waterway project to which the newspapers would devote pages of space? There lay a much more fertile field for cultivating popularity than the routine work of caring for and improving the local harbors and creeks of the district. And when the Congressmen from the North Atlantic coast discovered the value of this political asset, the other coast Congressmen all the way around to the Pacific likewise had to have their share.

Whatever criticism may be made from the standpoint of the public interest as to this method of planning public works, engineers have no particular quarrel with appropriations to make surveys for waterways here, there or anywhere. The army engineer's business is to do what he is told to do, even though he be told to survey a canal to the moon.

Having made the survey, however, a new and far heavier responsibility lies upon him. It is his duty to advise the Government and Congress whether, on the whole, the improvement for which he has made the survey is a justifiable enterprise considering the benefits which it will confer upon commerce. Put in mathematical terms, the problem he has to solve is whether the total saving in cost of transportation through the construction or improvement of a proposed waterway will be great enough to pay the cost of maintenance of the waterway,

FIG. 1. MAP OF THE ATLANTIC COAST FROM BOSTON TO BEAUFORT INLET, N. C., SHOWING PROPOSED INLAND WATERWAY

plus the interest on the outlay for its construction.

The report has just been issued of the Board of Engineers appointed to conduct the survey of the Atlantic deeper waterways project from Boston to Beaufort, N. C. This Board was made up of some of the ablest and most experienced officers in the corps of engineers. In accord with the prevailing custom, the report of this Board was referred to the General Board of Engineers for Rivers and Harbors, which added its comments to the report. Both these reports were then passed upon by Gen. William H. Bixby, Chief of Engineers, who submitted the whole, with his comments thereon, to Secretary of War Stimson on Jan. 2 last, and the report was transmitted by Secretary Stimson to Congress a few days later.

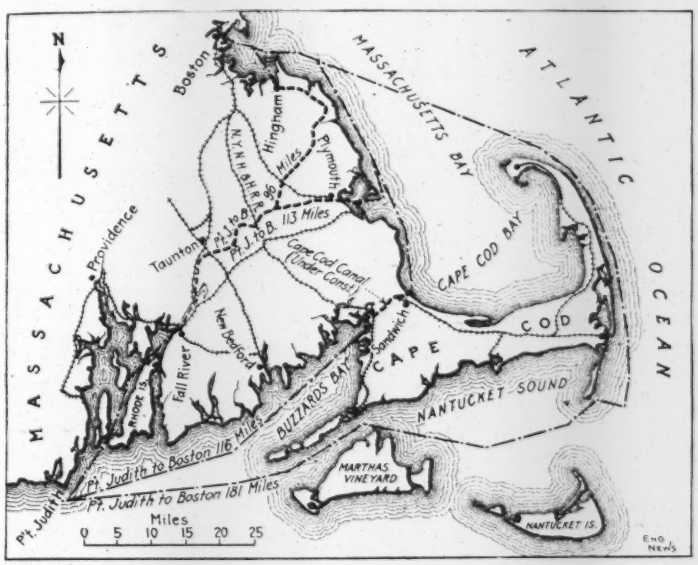


FIG. 2. PROJECTED WATERWAYS BETWEEN MASSACHUSETTS BAY AND LONG ISLAND SOUND

In reviewing the reports now before us on this waterway project, we desire to say in the first place that the country is vastly fortunate in having in its service a body of men of such high character and technical ability as the officers of the Corps of Engineers.

There is no greater need in this country to-day than the service of men of high character and reputation, thorough technical knowledge and broad judgment to pass upon projects for public expenditure. Everywhere, the demands are piling up for huge outlays of public funds upon this or that or the other great enterprise, all urged by their promoters as extremely profitable and absolutely essential to the public welfare. All our public treasuries, Federal, State and Municipal, would be bankrupted in short order were there no checks on the schemes of these promoters. Conservative and intelligent judgment upon these questions of public welfare is of the greatest possible public service at the present time, and the duty of rendering this service has been discharged with great fidelity and ability by the officers of the Corps of Engineers.

Turning first to the report of General Bixby, in which the whole matter is summarized, it may be said at once that the only part of the Atlantic deep waterway project which receives the final approval of the Chief of Engineers and his Advisory Board, are the waterways between Norfolk and Beaufort Inlet, estimated to cost $5,400,000 and the purchase and enlargement of the existing Chesapeake and Delaware canal at a cost of $12,500,000, in round numbers. The proposed waterway from Norfolk to Beaufort is to be 12 ft. in depth. The above outlay on the Chesapeake and Delaware canal would provide a 25-ft. depth; but it is recommended that a depth of 12 ft. be first secured.

The projected ship canal across New Jersey and the protected inland waterway along the Rhode Island Coast, which received the approval of the special Board of Engineers appointed to make the surveys, are not favored by General Bixby and his Advisory Board.

Other proposed links in the waterway are rejected by all the engineers concerned; but inasmuch as a great deal of engineering work has been done and much agitation has gone on concerning various of these Northern links in the Atlantic deep waterway scheme, it seems worth while to present here some fuller account of the examination and reports upon these schemes.

A CANAL FROM BOSTON TO NARRAGANSETT BAY

Beginning at the Northern end, a scheme has long been agitated for a canal from Boston to Narragansett Bay. The state of Massachusetts itself has spent quite a sum surveying routes for ship canals over this section. The estimated cost of such a canal varied from about $17,050,000 to over $40,000,000, according to the size of canal and the route chosen. These various schemes have already been passed upon by a Massachusetts State Commission which on May 1 last rendered a report advising that the construction of such a canal was not warranted at the present time.

Among the arguments against undertaking this work is the fact that the Cape Cod ship canal is now under construction by private enterprise and when completed will enable vessels to escape the most dangerous part of the voyage from Long Island Sound to Boston. Concerning the Cape Cod canal, the Board of Engineers say "the economic value of this canal with its exposed approaches has not yet been established."

In order that the Cape Cod canal shall be a commercial success, the risk of passage through it, including navigation of the shallow waters of Buzzards Bay, and the more or less exposed waters between the eastern end of the canal and Boston will have to be enough less than the risk of sailing around Cape Cod to warrant vessels in paying the tolls for passing through the canal. During the fall and winter months, it is probable

FIG. 3. PROJECTED WATERWAY ON SOUTHERN RHODE ISLAND COAST

that vessels will seek the canal; but during a large part of the year when the sea is calm, the extra run around the Cape may often be held to be worth while to save paying the canal tolls.

The Southern Rhode Island Waterway

The next link in the proposed waterway to be considered is an inland channel along the coast of Rhode Island, extending from the protected waters of Narragansett Bay westward to a point near Stonington, Conn., where vessels would emerge into the protected waters of Fisher's Island Sound. The total length of this inland channel would be about 36 miles, of which about 20 miles would be through tidal ponds and rivers. The estimated cost of construction is

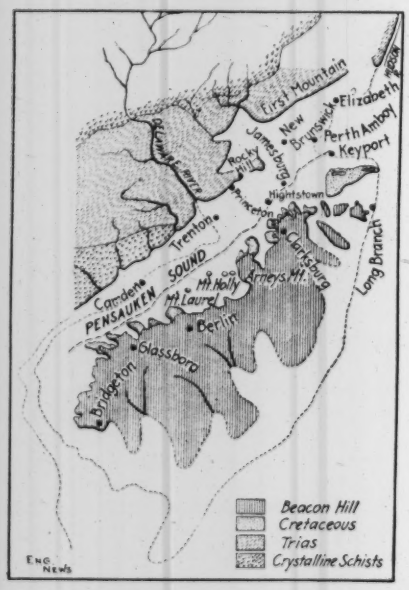


FIG. 4. NEW JERSEY IN THE PENSAUKEN PERIOD

from $12,000,000 to $24,000,000, according to the depth and width of channel adopted.

The arguments for the construction of this waterway are based almost wholly upon the reduction of risk and saving of time in the barges which ply between Narragansett Bay and New York or other Sound ports. Barges coming up the coast from Norfolk, of course, are seaworthy enough to traverse the more exposed waters around Point Judith.

The special Board of Engineers made a careful investigation into the advantages of such a canal, and were finally convinced that these advantages would be sufficient to justify the United States undertaking the construction. The canal recommended by this Board would have a depth of 18 ft. and a bottom width of 125 ft. The total cost is estimated as $12,322,000.

The Board of Engineers for Rivers and Harbors, however, was unable to take so favorable a view of the project. It says in its report: "The route would afford practically no saving of distance over the outside route and boats would probably prefer the latter except in stormy weather. This appears to be the least needed link in the waterway from Boston to Beaufort. It is very questionable whether the inside route would be used sufficiently to warrant the large expenditure required for its construction and maintenance."

One of the important arguments in opposition to this canal came from the Board of Underwriters of New York which stated, on the strength of the opinions of its surveyors, who are ex-sea captains, that the northern part of such a canal would be closed at least 4½ months in the year by ice. This closure would occur, moreover, during the season of Winter storms and as noted above it is only in stormy seasons that the canal would offer any advantages over the outside route.

A Ship Canal across New Jersey

By far the most interesting project in connection with the Atlantic deep waterway scheme is the proposal to build a ship canal across New Jersey from Philadelphia to New York City. This project has long been a favorite one for inland waterway promoters. Eighteen years ago the City Council of Philadelphia appropriated $10,000 to make surveys for such a ship canal. With this wholly inadequate sum, a general investigation of the route available for a ship canal was made under the direction of Prof. Lewis M. Haupt. The project never made any farther progress.

In taking up the project now, the Board of Engineers charged with the survey laid down certain excellent principles to govern the location of any ship canal built across the densely populated State of New Jersey. It was decided that such a canal should be so located as to eliminate so far as possible interference between land and water traffic. In other words, crossing of important railways by the canal was to be avoided. It was also thought desirable to have the canal avoid passing through any of the cities of New Jersey, thus saving right of way expense and interruption to the traffic by drawbridges, etc. These considerations led to the rejection of the canal route surveyed for the city of Philadelphia 18 years ago. Similar reasons caused the rejection of the project to enlarge the existing Delaware and Raritan Canal.

The surveys and investigations of the Board, however, showed that there exists a route across the State of New Jersey from deep water in New York Bay to the Delaware River near Bordentown, along which a ship canal [illegible] be excavated all the way to a depth [illegible] 25 ft. below sea level without enco[illegible]ring rock. The engineers made 211 [illegible]ngs

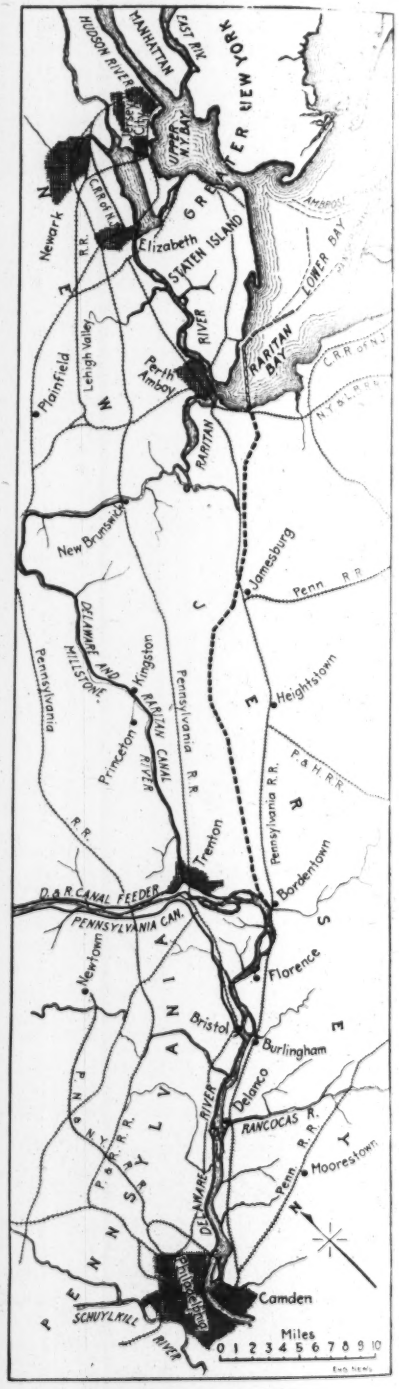


FIG. 5. PROJECTED SHIP CANAL ACROSS NEW JERSEY

along the line of the proposed canal, about 1000 ft. apart, and the only materials encountered were sand, clay and a little gravel.

The route in fact follows what is known to the geologists of New Jersey as Pensauken Sound. Investigations have shown that at a late geological period New Jersey was depressed considerably below its present level. The ocean extended as a broad strait across New Jersey to Camden on the South and New York Bay on the North. The mouth of the Delaware River was then located a considerable distance northwest of Trenton. This ancient strait was at a later geological period filled with alluvial deposits, but the terminal moraine during the glacial period did not extend as far south as this; hence the deposits along the line of the proposed canal are almost wholly of fine material with very few boulders and little gravel.

The total length of the proposed canal across New Jersey from the Delaware River to the terminus on lower New York Bay is only 33.7 miles. There are no sharp bends to interfere with navigation, no towns to pass through and there is plenty of waste land along the route where material excavated from the channel could be deposited with a short haul. Only insignificant streams cross the line of the canal and no trunk line railways. The only railways of any importance which cross the canal line are the roads leading to the New Jersey seashore resorts.

The Board gave much consideration to the question whether such a canal should be built with locks or at sea level. The difficulty in constructing a lock canal is the lack of a water supply for the summit level. The estimated amount of water required was 600,000,000 gal. and no such amount is available from streams located in the State of New Jersey. The only possible water supply would be by gravity flow from the upper waters of the Delaware River or by pumping. For the Delaware River supply a feeder 51 miles long capable of carrying 980 cu.ft. of water per second would be necessary. The estimated cost of such supply was $10,000,000, which was somewhat more than the present cost of a pumping plant of equal capacity plus the capitalized cost of operating it.

The final estimates, however, showed that a lock canal with a summit elevation of 70 ft. would cost about $49,050,000 while a sea level canal would cost only about $1,000,000 more, including in each case the annual maintenance and operating charges capitalized at 3%.

Studies were also made as to the cost of sea level canals of different depths; but as may be readily understood, the added cost of additional depth was a comparatively small amount. Thus an 18-ft. deep sea level canal was estimated to cost $40,336,000, while a canal 25 ft. deep would cost only $43,000,000 and the maintenance of the deeper canal would be practically no greater. The project which the Board finally adopted, therefore, is for a canal 25 ft. deep below sea level with a bottom width of 125 ft. and side slopes of 1 on 2 up to the level of + 15 and above this of 1 on 1¼ with a 10-ft. berme at each 50 ft. of vertical height.

Besides the canal proper, the Delaware River would require to be improved by dredging from Allegheny Avenue, Philadelphia, to Bordentown, N. J., a distance of 26 miles, and at the northern

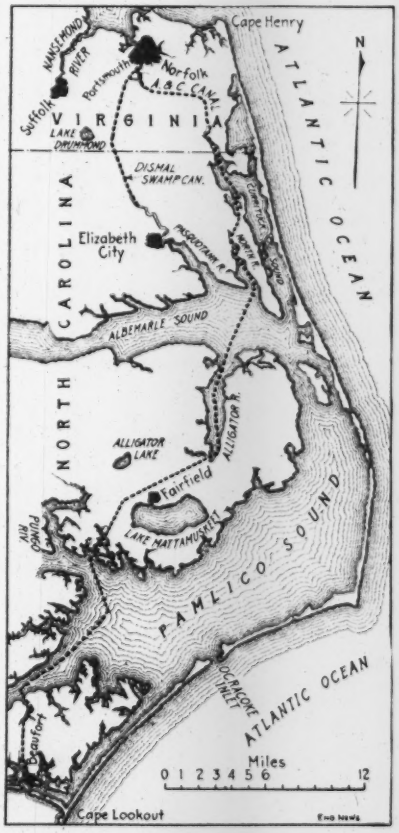


FIG. 6. PROJECTED WATERWAY FROM NORFOLK TO BEAUFORT INLET

end of the canal a channel 12.1 miles long would have to be dredged through Raritan Bay to deep water. The estimated excavation necessary for the construction of the proposed canal and the connecting channels through the Delaware River and New York Bay amounts to the large total of 186,000,000 cu.yd. in round numbers.

The estimate for cost of excavation was 10c. per cu.yd. for all material lying below sea level, which it was assumed could be handled by hydraulic dredges. For materials lying between sea level and + 15 ft., 15c. per cu.yd. was assumed. For material lying above this level, as well as for all material which had to be rehandled, the estimate was 20c. per cu.yd.

The final estimated cost of construction of the whole waterway from Philadelphia to deep water in New York Bay, including a 10% allowance for engineering and contingencies, was $45,000,000 in round numbers. The annual cost of maintenance is estimated at $312,000 per annum.

The distance from the Philadelphia wharves to the Battery in New York City by this canal would be about 87 miles as compared with about 274 miles by the outside route down Delaware Bay and through the ocean to Sandy Hook. Assuming that a speed of 8 miles per hour can be made through the canal and that in the Delaware River and in New York Bay large boats would run about 20% slower than in the open sea, vessels capable of running 15 miles an hour in the ocean could make the trip from Philadelphia to New York via canal in about 8 hours and 40 minutes as compared with about 20 hours for the trip for the outside route.

While the cost of the proposed inland waterway and of its maintenance can be determined with a fair degree of accuracy, a much more difficult problem is presented by the task of estimating the probable traffic which will use the canal. It is only by some such estimate, however, that a determination can be reached as to whether the public benefit from the construction of such a canal would be commensurate with its cost.

Investigation of the probable volume of traffic through the canal was made by a committee appointed by the President of the Atlantic Deeper Waterways Association. The chairman of this committee was Prof. Emory R. Johnson, of the University of Pennsylvania. This committee estimated the probable volume of traffic through the canal during the early years of its operation at 5,200,000 tons per annum, of which 3,400,000 tons would be coal. This the Committee itself called unduly conservative in view of the fact that the total tonnage of freight moved by rail annually across New Jersey is in the neighborhood of 54,000,000 tons.

The present freight rates between New York and Philadelphia on 6th class freight are stated to be $1.90 per ton by rail and $1.60 for traffic by sea via the outside route. The present annual volume of traffic by water between New York and Philadelphia is 750,000 tons by sea and 400,000 tons by the old Delaware and Raritan Canal.

It is estimated that through the proposed new waterway 2000-ton barges loaded to 60% of their capacity could handle freight profitably between New York and Philadelphia at a rate of 60c. per ton with a time of transit of approximately 10 hours.

Assuming 5,600,000 tons as the prob-

able annual traffic through the canal during the first few years, a saving of 40c. per ton in the freight rates on this traffic would make a total reduction in the cost of transportation of $2,240,000. Comparing with this saving the annual cost of the canal, interest at 3% on the estimated cost would amount to $1,350,000 per annum and adding operation and maintenance, the total annual cost would be $1,662,000.

On the basis of these figures, the special board in charge of the surveys recommended that the sea level canal be undertaken by the Government. It advised, however, that the construction should be deferred until after the two more southern sections of the proposed waterway should be completed and until the plant owned by the United States now at work on the Panama Canal should become available for use.

The Board of Engineers for Rivers and Harbors, in reviewing the report of the special board, declared that in its belief it is improbable that the commercial benefits of this deep draft sea level canal across the State of New Jersey would be commensurate with the very large expenditure proposed. Even if the estimates of cost and of traffic be taken as correct, interest plus the cost of maintenance would amount to about 30c. per ton, or 4 mills per ton mile, "which is a heavy charge for the public to assume for the benefit of shippers." The board noted that the estimates for a saving by the inside route are based on the carriage of freight in 1000 and 2000 ton barges, and such vessels could be accommodated by a 12-ft. canal as well as by a 25-ft. one. The board, therefore, did not recommend the present adoption of a project for a 25-ft. canal along this section and said it was not convinced that a canal of much less depth would not adequately meet the demands of commerce. After the completion of the two southerly links of the proposed coast waterway and of the Panama Canal so that the plant used there by the Government will be available, commercial and transportation conditions may undergo changes which will affect more or less the present conclusions.

A 25-FT. CHANNEL TO CONNECT DELAWARE AND CHESAPEAKE BAYS

Turning now to the southerly links in the proposed waterway, as we noted above, these projects receive the unanimous approval of all the engineers concerned. The immediate purchase of the Chesapeake and Delaware canal is recommended. The enlargement of this canal to a depth of 25 ft. with a bottom width of 125 ft. is also recommended. The average annual traffic through the present Chesapeake and Delaware canal for the last five years has been 716,000 tons, which with average tolls of about 23c. a ton has given the Canal Company a gross revenue of $163,000. The Board estimates that over 1,000,000 tons of coastwise traffic would pass through the enlarged canal, while it would afford a short route from Baltimore to the ocean and benefit nearly 4,050,000 tons of ocean shipping. The total annual saving by the proposed canal is estimated in round numbers at $1,400,000, which is considered ample to justify the proposed expenditure of $10,000,000 for construction and $2,050,000 for the purchase of the existing canal.

A 12-FT. WATERWAY THROUGH THE NORTH CAROLINA SOUNDS

Regarding the North Carolina section of the proposed waterway from Norfolk to Beaufort Inlet, investigations made by the Board resulted in the choice of a route by way of the Albemarle and Chesapeake Canal, Pamlico Sound and Adams Creek with an estimated total cost of construction slightly less than $5,000,000. The Board of Engineers in 1902 estimated that the annual saving of freight charges by completing this inland waterway link would be not less than $600,000 per annum. This estimate is adopted by the present board.

The members of the special board of engineers charged with the survey of the whole route from Boston to Beaufort Inlet were Cols. W. M. Black and Frederick V. Abbot, Lieut. Cols. J. C. Sanford and Mason M. Patrick and Major R. R. Raymond.

Absurd Water Meter Rates

BY A. MARSTON*

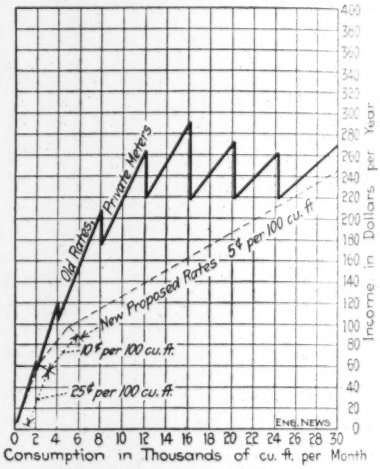
The accompanying diagram, taken from the report of a commission created to appraise the water-works of Freeport, Ill., shows what absurdities in the way of water rates are sometimes found in actual use. The old rates shown in this diagram were as follows:

Gallons per day	Cents per 1000 gals.
0- 500	35
500-1000	32
1000-2000	28
2000-3000	24
3000-4000	20
4000-5000	15
5000-6000	12
6000 and over	10

Although the above table looks plausible to the eye, the diagram shows that it produces very absurd results in practice. For example, the user of 6000 gal. of water per day will pay exactly the same price as the user of 5000, 4000 or 3000 gal. of water per day; 3999.99 gal. per day will cost $292 per year, but by turning another pint of water a day through the pipes the consumer would reduce his annual water bill $73.

The new rates recommended by the commission, in case a new franchise is granted to the company, are also shown on the diagram. They are based on the unit of 100 cu.ft. rather than 1000 gal. of water, and changes in the rates are made at even thousands of cubic feet per month. The new practice greatly simplifies the computation of all bills.

The Freeport Water Works Appraisal Commission was appointed in accordance with the terms of a water-works franchise granted in 1881, and expiring July 1, 1912. The members of the commission are John W. Alvord, Consulting Engineer, Chicago, Ill.; Dean F. E. Turneaure, University of Wisconsin, Madison, Wis., and the writer, and our duty, as provided in the franchise, was to make a valuation of the water-works with a view to possible purchase by the city.



OLD AND PROPOSED NEW WATER RATES FOR LARGE WATER CONSUMERS, FREEPORT, ILL.

By stipulation between the water-works company and the city, however, the commission has also been called upon to report upon necessary improvements to the water-works plant, and upon equitable rates for the future in case the city elects to grant a new franchise. The report is just completed, and was to be presented to the city council during the week beginning Apr. 25.

Iron Ore Reserves in Michigan are discussed in a pamphlet by G. K. Leith, recently published by the U. S. Geological Survey. Dr. Leith examined the iron mines last summer for J. R. Finlay, of New York, who evaluated all mining properties in Michigan for the state tax commission.

The ore reserves in 1911 (not including low-phosphorus, high-silica ores) are estimated at about 169,580,000 long tons. The total shipments since the opening of the various fields amount to about 219,230,000 long tons. Dr. Leith states that he believes this ratio of reserve to total shipment will be maintained for many years—in other words, that as much ore will be discovered yearly as is mined yearly.

*Dean and Director, Division of Engineering, Iowa State College, Ames, Iowa.

Letters to the Editor

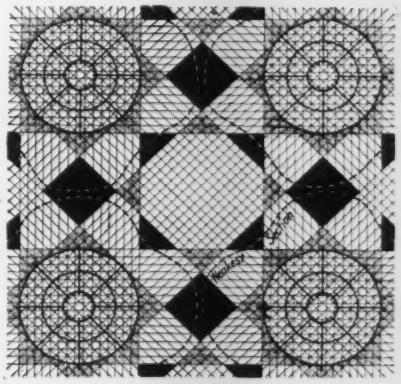
Facts Concerning Stresses in Flat-Slab Concrete Floors

Sir—In your issue of Apr. 18 the writer noted with some little interest your description of a visionary ideal treatise on reinforced concrete, and also what is labeled as a simple analysis of stress in radial reinforced flat slabs by S. E. Slocum. Apparently this method hardly comes up to the editorial ideal, and certainly it does not meet the writer's view in this matter.

The discussion is based on details of the "Mushroom" system, which is not a radial type of reinforcement as far as slab rods are concerned, since the slab reinforcement is placed in belts of parallel rods. Prof. Slocum takes into consideration the efficiency of the ring rods as circumferential reinforcement, and strangely enough fails to consider the slab rods as circumferential reinforcement. In other words, the wide belts of bars running in four directions form a series of circumferential frames polygonal in form, some of these frames being tangent to the ring rods, and as they approach the center of the column they form inscribed polygons, one within the other, each a circumferential frame capable of resisting circular stresses very efficiently. This statement is true of all multiple-way slab reinforcement arranged in the tensile zone over the column at the top of the slab and in the tensile zone in the bottom of the slab between columns, whether this reinforcement runs in two directions or in four directions, and it is this ability to resist circular as well as radial stresses which lends to flat-plate reinforcement so arranged its commercial efficiency.

The first glaring error in Prof. Slocum's so called simple analysis to which attention should be called is as follows: On p. 728 he states the formula for the bending moment of a continuous beam as $\frac{WL}{12}$ at the supports and $\frac{WL}{24}$ between supports, and deduces the conclusion that for the flat plate the formula for moment over the support is $\frac{WL}{48}$, which he states agrees with the formula determined by experiment and used in practice, namely M equals $\frac{WL}{50}$. Evidently the professor is lacking in familiarity with practical work in flat-slab construction and the methods that are used in practice, since this $\frac{WL}{50}$ is not the moment at the support, but is the moment along the line of weakest section, shown in the diagram herewith by the heavy dotted lines. This moment is the moment between the columns in direct lines, and at the one-third point approximately in diagonal lines, and represents the maximum tension in the slab rods. It has absolutely no relation whatever to the bending moment over the supports.

In practice with the "Mushroom" system there is an amount of steel over the support which renders the slab in the vicinity of the column stronger than at the line indicated, and hence no computation whatever is usually made for the construction at the support. Were it possible to divide the construction into beam strips as Prof. Slocum endeavors to do, and the diagonal slab belt carries one-fourth of the load as assumed by Prof. Slocum, then the moment on the



SKETCH PLAN OF TURNER'S "MUSHROOM" FLOOR; LINE OF WEAKEST SECTION INDICATED

diagonal strip treated as a continuous beam would be 1.414 times as great as the moment on a strip directly from column to column, since the span is that much longer; the arrangement of metal accordingly in Prof. Slocum's table would be a logical absurdity, in view of his premise.

The investigation reported by Prof. Hatt, in which the measurements of the steel stress were taken in the center of the diagonal belt, agrees correctly with the flat-plate theory of the stress, namely that the compression in the concrete in the diagonal center of the span is practically zero. The stress in the steel directly underneath would be perhaps the least that would occur at any point in the belt, while the maximum stress in the steel would occur at the line noted as the line of weakest section. Another maximum would occur over the columns. The minimum stress in the steel would occur between the line of weakest section and the center of the support, and again another minimum in the center of the panel on the diagonal belts, while on the belts directly from column to column we would have one maximum directly over the supports and another maximum in the center between supports.

Prof. Slocum's illogical disregard of the circumferential frames formed of the slab reinforcement is very surprising indeed to the writer, in view of his allowance and computation of the value of the ring rods as circular reinforcement about the column head. The simplicity of his method is apparently based on impossible assumptions and a total lack of familiarity with practical methods of design. A study of the diagram herewith and the measurements recorded by Prof. Hatt, taking into consideration that the Franks Bldg. is a cantilever flat-slab construction identical with the "Mushroom" system" except for the substitution of square carrying rods for circular ring rods (which by placing one square within another offers a similar type of resistance though not theoretically as efficient), will serve to bring out clearly the points suggested in this letter.

It might be remarked incidentally that the Franks Bldg. follows the type of practice which the writer introduced into one of his early buildings, namely, the John Deere Plow Co. building at Omaha, Neb., in which he used 16 rods in the diagonal direction and 14 directly between columns in a square panel 18 ft. 9 in. c. to c. of columns. Observations on a large number of tests convinced the writer that this arrangement was not altogether logical, and since that time we have been using an equal number in the two directions, as we did in the first buildings put up. Further, the writer's investigation seemed t indicate that with equal numbers of rods in the belts, and with square panels, the maximum stresses in the slab rods are approximately equal in the different belts.

C. A. P. TURNER.

816 Phoenix Bldg., Minneapolis, Minn., Apr. 22, 1912.

The Battle of the Gages in Australia

Sir—I notice in your issue of Dec. 7, 1911, an editorial dealing with the different gages of railways in Australia. The 4-ft. 8½-in. gage has been definitely adopted for the Transcontinental line from Port Augusta to Kalgoorlie, but it

by no means follows that the 4-ft. 8½-in. gage will be adopted throughout Australia.

As a matter of fact, we have in Queensland alone, at the present time, over 4500 miles of 3-ft. 6-in. gage, of which the government railways cover 4250 miles. To alter these lines to the 4-ft. 8½-in. gage it has been estimated would cost something like $120,000,000—practically equal to the cost to date of our present mileage. In addition to this there are nearly 2000 miles of 3-ft. 6-in. gage line under construction in Queensland, and to alter this to 4-ft. 8½-in. gage would cost roughly another $50,000,000.

I may say that so far the Legislature here has not given the slightest indication of any intention to alter our 3-ft. 6-in. gage to 4 ft. 8½ in. except as regards a single connection between Brisbane, our capital, and the New South Wales border.

W. PAGAN,
Deputy Commissioner of Railways of Queensland, Australia.
Brisbane, Australia, Apr. 2, 1912.

Sir—I note in your issue of Dec. 7, 1911, a reprint of portions of the paper of Jas. Alex. Smith, President of the Victorian Institute of Engineers, also an editorial comment on the same subject, "The Problem of the Gage of Australian Railways."

In your comment on the subject, you state that as the expense of changing gage will fall on the several states, Victoria urged the adoption of the 5-ft. 3-in. gage, as that is the Victorian standard. It is generally understood that whatever form of conversion may be decided upon, the states will not be called upon to bear all the expense. One of the powers of the Federal Parliament is in respect to the "Control of Railways with respect to transport for the Naval and Military purposes of the Commonwealth," and public opinion points to the probability that the Federal exchequer will meet part of the bill regarding change of gage.

You say also in your editorial that the cost of hauling freight has been reduced to such a low figure with the present gage and present rolling stock that possibilities for further economies in that direction are well nigh exhausted. In all this gage discussion, however, the possible future of Louis Brennan's "monorail" seems to be ignored, but I am sure there are many in Australia as elsewhere who would be glad to see an article in your columns showing the present state of development of Brennan's invention and any figures of recent trials.

H. V. FRANCIS.
Superintendent and Resident Engineer, of the Northern Territory Railways.
Darwin, N. T., Feb. 22, 1912.

[There is no reason to suppose that the Brennan monorail contains possibilities which should be taken into consideration in fixing upon a standard gage for Australian railways. Brennan's invention, which was fully described in this journal when it first appeared several years ago, displays remarkable ingenuity and has possibilities of commercial usefulness for light-traffic railways where first cost of construction must be reduced to the lowest point. We say possibilities, for notwithstanding that several years have elapsed since the invention was made public, the first commercial line on this system is yet to be built. For heavy-traffic railways, however, there is nothing to indicate that the monorail system in any form could reduce the cost of construction or operation below the costs at present prevailing on ordinary railway lines.—ED.]

Unbalanced Thrust on Piers of the Tempe Bridge

Sir—The writer wishes to call in question the stability of the intermediate piers of the reinforced-concrete arch bridge at Tempe, Ariz., described in your issue of Mar. 28, 1912, p. 578. These are founded on twin cylinders, 6 ft. in diameter, carried to bed rock. Thus the piers are carried on stilts, as it were, and are incapable of resisting any considerable unbalanced horizontal thrust.

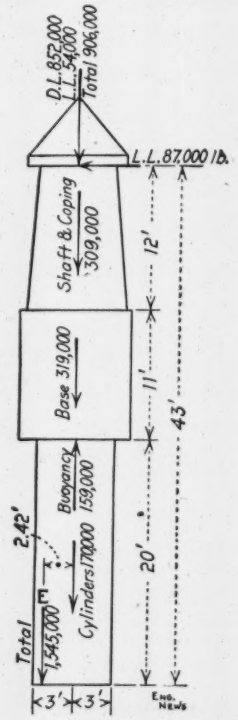


DIAGRAM SHOWING UNBALANCED THRUST ON PIER 8 OF TEMPE BRIDGE

From the data given in the article the writer has computed roughly the loads on pier No. 8, as shown herewith. The dimensions of the pier are assumed as shown; a considerable variation in these would not materially affect the results.

When one span carries live load and the adjacent spans none, or when one span has a greater live load than the adjacent spans, there is an unbalanced horizontal thrust at the top of the pier. A fixed arch is capable of taking up part of this thrust, but a three-hinged arch such as was used in this case cannot carry any of the unbalanced thrust. This is one of the disadvantages of the three-hinge type. Consequently the entire unbalanced thrust must be resisted by the pier in bending. Obviously it is not permissible to count upon the lateral resistance of the earth to any extent.

The arches are designed for a 15-ton traction engine, or 100 lb. per sq.ft., uniformly distributed. The traction engine alone will give an unbalanced horizontal thrust of about 43,000 lb. In order for no unbalanced thrust to exist under the specified uniform load of 100 lb. per sq.ft., the three spans between abutment piers must be equally and symmetrically loaded, which is a very improbable case. It seems reasonable to assume, however, that the intermediate span may have a load of 50 lb. per sq.ft., while the adjacent spans carry no live load, as for instance, during the passage of a drove of cattle; or, what amounts to substantially the same thing, one span may have 50 lb. per sq.ft. more load than the adjacent spans. To put the matter in another way, it seems that if the structure is designed for 100 lb. per sq.ft., at least 50 lb. per sq.ft. should be assumed in computing the unbalanced thrust. Under this assumption we get an unbalanced thrust of 87,000 lb., as shown in the figure.

The upward pressure of the water has been allowed for, the net uplift being about 159,000 lb.

The loads being assumed as shown, the resultant pressure at the base of the cylinder, or 1,545,000 lb., is applied at a distance E from the center line of pier equal to

$$\frac{87{,}000 \times 43}{1{,}545{,}000} = 2.42 \text{ ft.}$$

Evidently if this condition should occur the concrete at the edge of the cylinder would be crushed, and the pier would rotate about the edge of the base. Any lateral displacement d of the top of the pier would cause the crown of the intermediate arch to fall about $3.2d$, and the crowns of the side spans to rise a like amount. The dead-load thrusts would then be unbalanced, thus hastening the collapse of the pier.

The question of unbalanced live-load thrusts has heretofore been considerably neglected in the design of arch bridges. It should be especially noted that three-hinged arches require heavier piers and abutments than do corresponding fixed arches.

VICTOR H. COCHRANE.
Kansas City, Mo., Apr. 1, 1912.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
505 Pearl St., New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

CHARLES WHITING BAKER, Editor.

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

To foreign countries, including postage, $9.00 or its equivalent, 36 shillings: 36 marks: or 45 francs.

Notice to discontinue should be written to the New York Office in every instance.

Advertising copy should reach New York Office by Thursday of week before date of issue.

Entered at New York Postoffice as mail matter of the second class.

CIRCULATION STATEMENT

During 1911 we printed a total of 931,958 copies.

Of this issue, 19,000.

None sent free regularly, no returns from news companies, no back numbers kept beyond current year.

Contents

*Hydraulic Regrading in Portland, Ore. 909
Tests on Compressed Steel Ingots... 909
*A Simple Load-Weighing Apparatus for Large Testing Machines 910
Engineering Problems in Alaska.... 911
*140,000-Volt Power Transmission.. 912
*Rapid Construction of a Small Reinforced Concrete Bridge; P. E. Green 918
Oil-Fire Extinguishers for Naval Vessels; Henry Williams..... 921
*Concrete Mattress Bank Protection; B. Okazaki 922
An Accident to the Paving of Owl Creek Dam, Belle Fourche Irrigation Project, South Dakota..... 925
*A Novel Factory Building..... 926
*Spreading of a Railway Embankment on Soft Clay..... 929
*The Army Engineers' Report on the Proposed Atlantic Coast Deep Waterway 930
*Absurd Water Meter Rates; A. Marston 934
LETTERS TO THE EDITOR..... 934
*Facts Concerning Stresses in Flat-Slab Concrete Floors; C. A. P. Turner—The Battle of the Gages in Australia; H. V. Francis; W. Pagan — *Unbalanced Thrust on Piers of the Tempe Bridge; Victor H. Cochrane.
EDITORIAL 937
The Fire Loss and the Prevention of Disaster—A Project for 51,000 Miles of National Highways—A Novel Water Supply Ruling of the Nevada Public Service Commission and Reflections on State Administrative Control—What Is the Remedy for Mississippi Floods?
*The Diesel Locomotive: Reasons for the Slow Adoption of Diesel Engines in the United States..... 941
ENGINEERING NEWS OF THE WEEK 944
PERSONALS 945
ENGINEERING SOCIETIES 946
ENGINEERING LITERATURE..... 947
*Illustrated.

Engineering News

Modern progress and practices which savor of the middle ages sometimes go almost hand in hand. A press dispatch of Mar. 22, from a city in the Canadian Northwest, states that the city council voted the day before to buy a motor-driven chemical and hose wagon, and at the very same meeting decided to engage a water finder hailing from Hamiota to "make a thorough investigation with his magnetic instrument of all possible sources of water supply." Comment is unnecessary.

The Fire Loss and the Prevention of Disasters

The fire loss cannot be prevented by law alone according to an opinion expressed by C. M. Goddard, in an address before the Boston Society of Architects. He stated that the loss of life and property by fire can be stopped only by educating public opinion to look upon such a loss as due to someone's carelessness or neglect. To quote further:

Cities will still discover that almost every known law as to theaters is evaded as soon as such spasms of public horror as that caused by the Iroquois disaster have subsided. Courts will acquit men, like the proprietors of the Triangle Shirtwaist Co., in the face of conclusive evidence that violations of the law caused the death of 146 human beings, because forsooth, it could not be proved that the violation was the actual cause of the death of the poor girl specifically mentioned by name in the indictment.

People will still plead for the shingled roof from esthetic and commercial reasons in spite of the fact that it is admitted by all experts and every fire chief to be one of the most flagrant causes known for setting fires and producing conflagrations. Notwithstanding the fact that hundreds of lives and millions of dollars are annually lost through fires from "strike-anywhere" matches, men will offer to Massachusetts legislators as a reason why the sale of other than safety matches should not be prohibited, that the carrying of a box of matches in the pocket would disfigure the symmetry of the outline of a man's dress suit; and items such as recently appeared in the Cleveland "Plain Dealer," announcing that five babies were burned to death in that city from match fires inside of three days, will still adorn our daily papers.

Mr. Goddard's statements that we are not a people who are taught by startling examples, that the effect of such examples is transient and that our teaching must be by education which makes for permanent character, may have some bearing on other losses besides those by fire. Recent events have demonstrated that when the public demands a sufficiency of lifeboats on ocean liners, the boats are provided. But how many of the people in the crowds that will burden our river and sound excursion boats this summer will make any serious effort to investigate the adequacy of the safety equipment carried?

A Project for 51,000 Miles of National Highways

The National Highway Association, of which Charles Henry Davis, of South Yarmouth, Mass., is president, has published a map of the United States on which it has laid down a proposed system of national highways, having an aggregate length of 51,025 miles. It proposes this system as "a broad and comprehensive system of national highways to be built, owned, and maintained by the National Government."

The network which is thus laid down (it is a network with very large meshes) is professedly a system of through roads, which includes three main east and west transcontinental highways and three main north and south highways, with a combined extent of about 17,000 miles, and in addition 23,000 miles of "trunk" highways and about 11,000 miles of so called "link" highways.

The document before us makes no estimate of the cost of this system of national highways and we have therefore made some rough approximations to get an idea as to what the project really involves.

It should be understood in the first place that these highways are intended primarily for automobile traffic, which means, of course, automobile touring traffic, since for long-distance freight transportation it is impossible for haulage over any road surface to compete with the low cost of hauling on a railway. As the roads must stand automobile traffic and high-speed automobile traffic at that, and are advocated as a system of "good roads," it will certainly not be safe to assume any smaller figure for their average cost than $13,000 per mile. In fact, when it is considered that a large proportion of this 51,000 miles must be built in inaccessible locations where road materials will be subjected to long haulage, this figure might be largely exceeded.

Assuming this figure, however, the total cost of 51,000 miles of road would amount to $663,000,000 in round numbers. Taking the annual cost of maintenance of these highways at 10% of their cost and the interest charge on their cost at 4%, the annual cost to the nation of supporting this system of highways would amount to $92,000,000. It seems probable that Congress will hesitate a long time before it will undertake an enterprise involving such a heavy annual expenditure for the benefit of the com-

paratively small proportion of automobile owners who can afford the time and money to engage in long-distance touring. We may go a step further, and say frankly that to propose such an expenditure of the public money for the benefit of a few wealthy pleasure seekers at a time when the masses of the people are crying out in protest against the increased cost of living seems like trifling with a grave situation.

In saying this we are not opposing the expenditure by the states themselves of moderate sums to construct short lengths of improved highway which may be needed to fill out gaps between sections of road already improved. Such work in the densely populated states of the East may often be a reasonable recognition of the rights of automobile users, and such work can be done without undue burden on the taxpayers, and without opening a sluice-gate from the federal treasury which, when once opened, it would be difficult to close.

Every engineer who has studied the road problem carefully and intelligently agrees that expenditure on highway improvements should be concentrated first of all on the roads radiating from the centers of population. These are the roads which are most used for commercial purposes. Improvement of these roads aids the farmer to bring his product to market and carry home his purchases, and aids the consumer in town or city to supply his wants at a reasonable price. As the public has to pay for building good roads, the roads should be built where they will be of the greatest public use.

It is fair to say, however, that probably many of those who are interested in various projects for through highways are not looking forward to any huge expenditure by the national government on a vast network of paved roads stretching across prairie, mountain and desert. What they are working for and planning for is merely the construction of a good earth road in districts where there is now nothing but a wagon track. As automobile pleasure touring is only carried on during good weather, such roads, which may be cheaply built and maintained, will answer most of the reasonable requirements of automobilists; and such roads can readily be provided by coöperation between the different states without resort to the federal treasury.

A Novel Water Supply Ruling of the Nevada Public Service Commission and Reflections on State Administrative Control

As the number, powers and duties of public-service commissions increase, new instances of state control of what have heretofore been regarded as purely local matters are reported. Thus in Wisconsin the Railroad Commission, which is now a public-service commission of the first order in both statutory power and working efficiency, insists on an equitable division of the cost of public water supplies between the city as a whole and the private consumers, while the new California Commission is taking up the troublesome question of extending the water-supply mains of private companies into new territory.

Again, comparatively new legislation has given the Wisconsin Commission more or less control over the quality of water supplies, while the same authority seems to have been included in the broad powers conferred in 1911 upon the newly created Nevada Commission. So far as we know, the Wisconsin Commission stands alone in having jurisdiction over municipal as well as private waterworks, although the forerunner of all these commissions, the Massachusetts Gas and Electric Light Commission, has for many years had as complete control of publicly as of privately owned electric-light and gas works.

An interesting water control case is set forth in the 1911 report of the Nevada Public Service Commission (Carson City, Nev). During the year a water consumer complained to the commission that the Reno Power, Light & Water Co. was supplying dirty water six months out of twelve. After investigation by its chief engineer, W. Freudenberger, and by Prof. Sanford C. Dinsmore, chief chemist, University of Nevada, the commission ordered that after Jan. 1, 1912, the turbidity of the water supplied by the company "shall at no time be greater than 30 parts in a million and that the monthly average shall not exceed 15 parts." The commission also ordered the company to make monthly sanitary analyses and daily turbidity measurements of its water supply and report these to the commission once a month.

It appears that the Reno supply is diverted from the Truckee River and from Hunter Creek and carried through open ditches to storage and distributing reservoirs near the city. These reservoirs have a combined capacity of 70,000,000 gal., or 8¼ days' supply. From analyses made by Prof. Dinsmore it was concluded that the water was free "from bacteria dangerous to health, the trouble being mainly its turbidity." Analyses of samples taken from the three reservoirs on July 3, 1911, showed an average turbidity of 83 parts per million, of which 47 were fixed and 36 were volatile matter. Thirty-nine daily tests from Aug. 2 to Sept. 25 showed that 38% of the time the water was below standard for clearness [standard not stated]. At this season the water is said to be at its best for the year.

We have gone into these particulars because this is the first instance, so far as we remember, of a state issuing an order that a local water supply must not fall below a given standard of *clearness*; and also because prior to this order and to quite recent action in Wisconsin, it has been state boards of health and not public-service commissions which have dealt with the quality of public water supplies.

We foresee the necessity for a careful consideration of the question: Shall public-service commissions or state boards of health have control of the sanitary quality of public water supplies? The growing practice is to give public-service commissions full control over the rates and the character of the service of all public-service corporations. There are strong reasons against vesting jurisdiction of the quality of water in one state board and other factors making up good service in another, and there are also strong reasons for not separating control over rates from control over character of service. Certainly our state boards of health should not be charged with the regulation of water rates, for an attempt to exercise a function so foreign to a health board would be almost sure to impair the efficiency of the work naturally belonging to such a board.

Arguments for giving state boards of health supreme control over the character of public water supplies spring to the mind of any one who thoughtfully considers the subject, but will not close analysis show that these arguments are founded on tradition and on chance practice rather than being based on careful analysis of the problem? We will not pursue the subject here further than to say that the Reno case which we have cited, involving merely a question of turbidity, had but a remote relation to health and that the decision of the Nevada commission in this case took into account the financial ability of the company to improve its water supply, a subject regarding which a public-service commission is peculiarly fitted to express an opinion based on information already within its possession or which it can readily obtain.

One possible way out of the dilemma —for such it seems bound to become in a number of states—is to give public-service commissions and state boards of health joint control over the character of water supplies. A strong objection to this is that divided control is likely to prove to be no control.

The final outcome of this and many other associated problems may yet be a consolidation of state boards of health, state public-service commissions and state departments of municipal accounting and statistics, all being brought into one State Department of Municipal Control, with bureaus of health, public utilities, statistics and whatever else time may show to be needed to meet our rapidly growing and quite as rapidly changing municipal conditions.

Of course, there will be strenuous objections to such a centralization of state administrative control; but so there was to state control of public-service corporations. The truth is that our municipal service, like our public-service corporation problems, long since changed from a local to a state-wide character. Whether the city itself or such agents of the city as water, light and street-railway companies perform the many services which the individual can no longer do for himself, there must be an increasing amount of state supervision in order to insure the greatest possible degree of efficiency in municipal and quasi-municipal service and at the same time the highest attainable measure of protection to life, liberty, happiness and property.

All this will not come through a haphazard creation of new commissions nor from a similar addition to the powers and duties of old commissions. The new needs must be studied and understood, both in themselves and in their relation to old needs, before they can be met with certainty and efficiency. Many experiments will be made before the best method of central state control comes into general use. Some of these experiments will be quite unnecessary; others may be necessary, or at least may yield light and guidance.

Here is one of the advantages to offset some of the disadvantages of our 46 independent state governments and their unending diversity of governmental methods. A great variety of plans will be tried in a comparatively short time and in these days of rapid interchange of information and free discussion a consensus of opinion regarding successes and failures will be reached and gradually uniformity will take the place of extreme diversity.

As we have seen, Wisconsin has gone further than any other state in giving its Railroad Commission broad powers over municipally owned as well as privately owned public-service industries. Far-away Nevada appears to have led the way in saying that a company must supply clear as well as safe water. New York, not mentioned heretofore in this discussion, is experimenting with water-supply control vested in three state departments—health, water supply (now conservation) and public service—as was set forth in our issue of Feb. 9, 1911, in an editorial on "Multi-Control of Water-Works by State Boards in New York and Other States." The activity on every hand is interesting and its variety suggests the need for systematic study to the end that the least efficient forms of central administrative control of municipalities and quasi-municipal corporations may be rejected and the best forms adopted as speedily as possible.

What Is the Remedy for Mississippi Floods?

There is no doubt that the flood now prevailing in the lower Mississippi Valley far exceeds in destruction any floods of that river hitherto recorded. This is not because the volume of water now passing down the channel of the great river so much exceeds that of any previous year. In fact, it is likely that the present flood flow is, if anything, a little less than that which was recorded in the great flood of 1897.

It is 15 years since the lower Mississippi Valley has suffered from a flood. During that period a vast amount of development has taken place in that fertile region. Under the protection of the levees, which have year by year been enlarged and made stronger, farms and plantations have been improved, land formerly worthless has been brought under cultivation, sawmills and sugar mills and cotton gins have been built, towns and villages have sprung up, a vast amount of money has been spent in buildings and improvements. The great damage wrought by the flood of this year, therefore, is largely due to the fact that there is a greater population and a larger amount of wealth to be affected by the flood.

Without doubt the disastrous experiences of the present year will bring forward anew for discussion the question what can be done to hold within bounds the lower Mississippi. There will be probably a renewal of the old attacks upon the levee system, and a new crop of proposals for various substitutes will be brought forward, each guaranteed by its inventor to accomplish the impossible. To those of our readers who are interested in this subject and desire to give it some study we can give no better advice than to refer them to the admirable monograph on Mississippi River Floods by the late William Starling, published just after the great flood of 1897.

We believe that in securing the publication of this paper by Mr. Starling, first in our own columns and later in separate form, we performed a valuable service to the engineering profession and to the public. Mr. Starling's paper has since been officially recognized by committees of Congress which have investigated the subject of Mississippi River floods as the highest authority upon the subject.

Doubtless the chief argument which will be brought forward by the opponents of the levee system will be the fact that the levees have this year failed to protect the valley from floods. The answer to this criticism is that the levees have failed because they were neither high enough nor strong enough for the work they were called upon to do.

It should be understood that in the building of the Mississippi River levees up to the present time, the problem put up to the engineers has not been: "What area protected from overflow, partly from direct state taxation and partly from federal appropriations. Of the total amount of levee work done up to 1899, over three-eighths had been done by the federal government at a cost of about $13,300,000. This was less than a third of the total amount expended for levee construction. It should be understood, however, that all the money spent on levee construction by the federal government is spent under the pleasant fiction—we can call it nothing else—that the work is for the benefit of navigation. Under the same pleasant fiction that it is doing something to improve navigation, the government has been for 15 years past spending $1,000,000 to $2,000,000 a year in dredging channels across the bars during the season of low water, for the benefit of a river traffic which has practically disappeared. Of course, all this dredging work on the river bottom at low water is wiped out at every high-water season and has to be done over again. If all the millions of dollars which have been spent on this dredging work in the low-water season during the last 15 years had been expended for building levees, it is reasonable to believe that at least two-thirds of the lives and property lost in this year's great flood might have been saved.

It does not seem necessary, either, that the pleasant fiction that levee building is an aid to navigation needs to be kept up in order to justify the expenditure of money by the federal government. We have frequently urged in these columns the proposition that river regulation on interstate streams is a field for federal rather than state action. While it is theoretically possible by interstate compact to carry out such work under direction of the several states, the difficulties of making and carrying out such compacts are so great that they must be recognized to be practically impossible. The Mississippi, for example, is an outlet channel for rivers flowing from more than twenty different states. It is not unjust that all these different states should bear some part, at least, of the cost of controlling the floods which they send down to the lower river.

No doubt the chief cost of the levees along the lower river ought to be contributed by the owners of the property protected. The increase in land values which has already taken place, with the increase in the value of farm products, makes it practicable to place assessments for levee work on the land owners, which would have been out of the question 20 years ago.

We alluded above to the probability that the present year's flood would bring forward a new crop of proposals for improving the levee system. The crop, in fact, is already here. *The Review of*

Reviews, for May, has an article entitled, "How to Remedy the Mississippi River Flood," written by P. S. Yoakum, Chairman of the St. Louis & San Francisco R.R. Co. Mr. Yoakum's proposition, briefly stated, is that the Panama Canal plant and organization should be transferred to the Mississippi Valley, since "it is now rapidly becoming idle and is especially adapted for dredging and constructing levees." In a letter to George H. Maxwell, Chairman of the National Drainage Congress, held last month at New Orleans, Mr. Yoakum says, "You understand better than others that opening streams and the removing of obstructions to permit the free flow of large volumes of water greatly relieves the pressure against the levees."

It is a pity that a man of Mr. Yoakum's prominence in the business world should lend the weight of his authority to such misleading ideas. The government has been dredging in the Mississippi River channel during the low-water season for 15 years, and has expended many millions of money in the work and it has had, of course, absolutely no effect on flood heights. As for using the Panama Canal plant to build levees along the Mississippi River, it would probably be the most expensive levee construction ever attempted in that valley. The Panama Canal plant was well chosen to do its especial work. There is very little of it, indeed, that would be economically adaptable to the conditions prevailing in Mississippi levee construction. The value of the Panama Canal plant at the present time is very much over-rated in the popular mind, anyway. During the years of hard work which the equipment down there has been through, much of the machinery has about reached its limit of economical life. Every manufacturer understands that when a machine in his shop reaches such a state of general wear that breakdowns are frequent and the maintenance bill is heavy, it is more economical to send the machine to the scrap heap and buy a new one than to attempt to get along with the old. Exactly the same thing is true of excavating machinery.

Another question which is doubtless destined to receive more or less discussion is whether some better construction than an earth embankment can be adopted for the Mississippi levees. Concerning these popular solutions of the Mississippi levee will you build to safeguard the country behind it and what will be its cost?" The engineer has been given a certain sum of money to be expended in a given district and has been told to make it go as far as possible in levee construction. Every engineer knows what is likely to happen if he is told that he can have a certain amount of money to build a dam with and to build the best dam he can with that sum. If the amount allotted is insufficient for thorough engineering and construction, the dam is likely to fail at the first high-water season. Hardly a month passes, in fact, that such failures are not brought to our notice.

The levees which confine the flood waters of the Mississippi are practically long earth dams. The main levees are now high enough and strong enough to hold the river within bounds in any ordinary season. For 15 years past there has been no serious overflow or breakage of the levees, but the experience of the present year demonstrates that the levees are far from being high enough or strong enough to confine such a flood as came down the river in 1897, or as is now flowing down the channel.

As has been frequently explained in these columns, the flood height on the Mississippi depends not alone on the volume of the flood's flow, but on the extent to which the river is confined between the levees. It makes a great difference, of course, whether this whole broad alluvial valley, 30 to 60 miles in width, is flooded or whether the flow is confined between the river's banks, topped by levees two or three miles apart. This is the first great flood in which the whole lower Mississippi has been confined between levees. In the flood of 1897, the great St. Francis basin in Missouri, some 6000 sq.miles in extent, was only partially inclosed by levees and at least 2000 sq.miles of it were flooded at the start by the high water spreading over the unleveed banks. A little later crevasses occurred in front of parts of the basin protected by levees so that the flood extended over nearly the whole basin. There were also numerous breaks in the levees protecting river basins farther down the main stream.

The loss of water from the main channel through these crevasses so affected the flood heights that the river gage records of 1897 are only a general indication as to what heights would have been reached by the flood volume of that year were the river entirely confined.

The conditions of 1897 have been substantially repeated this year. While the whole river is now inclosed by levees, the water has escaped by over-topping the levees and through crevasses, so that the flood heights reached this year, while exceeding any ever recorded, are still far below what would be attained if all the levees had held. If, then, the problem were put up to engineers as to what height of levee would be required to hold safely the greatest flood on record, *or possible*, it is probable that the present levee height would have to be raised 10 to 15 ft., or in some cases even more.

There is nothing impossible in such a raising of the levees. It is perfectly practicable to do the work if money enough is provided; nor would the expenditure be so enormous as might be thought. Some 13 years ago the late Captain Waterman, Secretary of the Mississippi River Commission, estimated that the entire levee system on the whole Mississippi River built up to that time contained 165,000,000 cu.yd. of earth and had cost a total of $47,600,000 in round numbers. He estimated that an additional expenditure of $20,000,000 would complete the entire levee system from the head of the St. Francis basin to the outlet into the Gulf and make it sufficiently high and strong to give protection against the highest recorded flood.

It is probable in view of the present year's experience in flood heights that this latter estimate is inadequate and that a considerably larger sum would be required. Even so, the great increase in land values and property values in the lower Mississippi Valley in the last 15 years makes an expenditure on its protection possible and worth while which would have been out of the question 15 years ago.

It may perhaps be argued that if such great floods as the one of the present year, or the one of 1897, were to come at no more frequent intervals than 15 years, it would be cheaper to endure the loss and inconvenience of these occasional devastations rather than spend the money a complete levee system would cost. It would be practicable, for instance, to protect the principal cities exposed to floods, such as Memphis and New Orleans, by levees so high and wide that no possible flood could over-top them. This, in fact, ought to be done in any event. As we pointed out at the outset of this article, however, towns and cities and manufacturing industries are growing up all through the delta region subject to overflow, and the lives and property at stake certainly justify the expenditure sufficient to give complete protection from floods.

The question who should bear the burden of paying for these levees is a knotty one. The present levee system has been built partly by the property owners themselves partly from the proceeds of taxes levied on the entire problem, Major Starling, in ENGINEERING NEWS, 15 years ago, said:

> During and after each high-water season, especially if it be attended by signal disaster, the newspapers teem with articles on the Mississippi problem. As a general rule, these productions are distinguished not so much for lack of ability as for lack of knowledge. Usually the writers have not taken the trouble to inform themselves upon the most elementary facts and principles involved in the discussion. Iron levees are proposed, wooden levees, stone levees, cement levees, brick levees, glass levees, paper levees. Each man takes up the subject for the first time, evidently supposing that nobody has thought about it except himself.

Concerning all these proposals, Major Starling said:

> Sound earth is a good enough material for levees without iron, brick, concrete, wood, paper or glass; but the bank must be carefully built, of sufficient dimensions and especially in case of a light or treacherous underground must have its base extended by a banquette. As to the cost, it may be briefly said that levees are the least expensive means of reclaiming overflowed lands that have ever been proposed.

What Major Starling wrote 15 years ago is true today. There is no reason to believe that any other kind of retaining wall than a plain earth embankment would be more safe and satisfactory to confine the flood waters of the lower Mississippi. As every engineer knows, levee building is a problem of dam construction, and while dams of masonry or concrete are chosen by engineers where rock foundations are available, the problem of building a dam on soft ground porous foundations has never been solved by engineers in any better way than by the construction of earth embankments. This is true not only of the levees in the lower Mississippi Valley but of the levees on every other alluvial stream the world over, and of the dams which have been built on alluvial formations in India, Panama, Mexico, United States and other countries. The famous dikes which protect Holland from the sea are earth embankments.

We are aware that there is a very general impression that an earth dam is a cheap, unreliable structure; but this impression is largely due to the fact that earth dams are by many supposed to require no engineering knowledge to construct. Their building is, therefore, entrusted to whatever contractor will offer to do the work for the lowest price, and a heap of dirt is piled up with little knowledge or judgment. So many dams are built in this haphazard way that the wonder is not that dam failures are so many, but that they are so few.

What is true of earth dams is true to a great or less extent of the earth levees along the Mississippi River. While the work done during the last 20 years and especially that during the last 10 years, has been generally under the charge of engineers, there are still incorporated in the levee line more or less stretches of old levees built with little care as to foundations or material. There are in the levee line stretches which have settled so that their summits are below grade. There are sections where wood and stumps have been buried in levees to afterward decay and cause interior hollows. It ought to be clearly understood, therefore, that the over-topping and breaking of levees in the present year's flood is no argument against the levee system or against the soundness and safety of properly designed and built levees. Neither is it any argument against the competency of the engineers engaged on levee work or their wisdom and judgment in building earth levees.

The Status of Block Signaling on American Railways

The extent of the use of block signals on the railways of the United States at the commencement of 1912 is shown by a series of tables in a report issued recently by the Block Signal and Train Control Board of the Interstate Commerce Commission. From this it appears that on Jan. 1, 1912, there were 76,410 miles of railway operated under the block system, being an increase of 5141 miles for the year 1911. The aggregate length of all the roads having this system was 176,844 miles, so that they had about 43% of their length thus operated. The total mileage for the same date is not given, but approximated probably 250,000 miles, so it may be said that about 30% of the total railway mileage is operated under the protection of the block system in some form. This certainly cannot be considered as a satisfactory showing from the point of view of safety and efficiency in the operation of railway traffic.

Of the total 76,410 miles (of road), 20,335 miles had the automatic system and 56,075 had the manual system, the increase for the year being, respectively, 2824 and 2517 miles. The tables include eight railways which had not reported the use of the block system previously. The most important of these were the Denver & Rio Grande R.R., which equipped 7.7 miles, and the New York, Chicago & St. Louis R.R., which equipped 15.4 miles. From a comparison of the figures of certain roads for the two years 1911 and 1912 it appears that there have been some notable changes; these represent an increase of 2451 miles of automatic and 4932 miles of non-automatic block signaling, but on the other hand the figures show also a decrease of 2825 miles in the latter. There is, however, no decrease in the automatic mileage. The figures showing work planned to be done during 1912 for the extension of existing block-signal installations show 834 miles of automatic signals for 11 roads, and 32 miles of non-automatic signals for one road.

An interesting feature of the report is a list showing for each road the total mileage of track and the percentage of this total which is equipped with the block system. There are 35 companies having 100% of their length equipped and 15 having 90% and over equipped, but, of course, several of these have only a small total mileage. However, of the 50 roads having 90 to 100%, there are 13 with over 1000 miles each, and four of these have over 4000 miles each. On the other hand, there are a number of important lines of extensive mileage which have a very small percentage operated under the block system. Thus among lines having less than 1%, we note five of 220 to 2887 miles (aggregating 8126 miles) which have from 0.1 to 0.7%; and among the roads having less than 10% there are eight of 460 to 7290 miles each (aggregating 17,153 miles), which have from 2.2 to 8.2%. The next highest is the Illinois Central R.R., whose defects in this respect have been noted recently. Of its 5027 miles of track only 12.7% (638 miles) are equipped; this comprises 621 miles of automatic and 17 of non-automatic signals.

Semaphore signals are used in the great majority of cases. Those having arms which move in the upper quadrant (a comparatively modern innovation) are used on 2026 miles of road (with 3700 miles of track). Three-position signals are used on 2535 miles of road (4892 miles of track). Alternating current is used in signal-operating circuits for 302 miles (811 miles of track), and in track circuits for 316 miles (898 miles of track). In certain cases where two single-track roads are parallel and close together, safety and traffic capacity are increased by operating them as a section of double track, under joint agreement. This feature of railway operation has been discussed in our columns, and the report under consideration notes four such cases in which these joint sections are equipped with block signals. These cases aggregate 82 miles and range individually from 4.7 to 60.3 miles in length.

Permissive signaling (under the manual block system) is forbidden on 7597 miles of road, but is allowed on 51,425 miles; the permission to proceed is given generally by a three-position signal or a caution card, but in a few cases it is given by a two-position signal supplemented by a flag or lantern. The electric train-staff system is used on 32 roads, and the length of line thus operated on individual roads ranges from 0.7 mile to 72 and 109 miles. The two highest figures are for the Great Northern and the Southern Pacific, respectively.

A subject included in the report, but having no bearing upon the block-signal returns, is the extent to which the telegraph and telephone are used for the transmission of train dispatchers' orders which affect the rights of trains on the road. It appears that on railways operating 224,283 miles of road, the telegraph is used on 169,400 miles and the telephone on 58,584 miles. On some sections both of these methods are used. As compared with 1911, these figures represent an increase of 6867 miles for the telephone and a decrease of 5811 miles for the telegraph.

In the accompanying table some of the figures of the report are given as a matter of record, and these show also the different kinds of signals and signaling in use.

TABLE OF BLOCK SIGNAL CONDITIONS ON AMERICAN RAILWAYS

	Length of Road, miles	Length of Track, miles
Block system, automatic	20,335	33,425
Manual, nonautomatic..	56,075	66,072
Total	76,410	99,498
Total passenger lines operated	176,845	201,686
Automatic Block Signals		
Single track	9,314	.....
Double track	9,843	.....
Three- and four-track..	1,178	.....
Total	20,335	33,425
Nonautomatic Block Signals		
Single track	47,068	.....
Double track	8,395	.....
Three and four track...	612	.....
Total	56,075	66,072
Kind of Automatic Signals		
Disk	2,121	4,260
Semaphores:		
Electro-pneumatic ...	424	1,402
Electric motor	16,849	25,692
Electro-gas	906	1,989
Total	18,179	29,083
Normal clear	.....	26,437
Normal danger	.....	6,907
Number of block sections 33,715		
Apparatus with Manual Block System		
Telegraph	37,417	43,018
Telephone	16,544	20,153
Electric Bells.....	511	725
Controlled manual, no track circuit.....	1,461	1,468
Track circuit at stations	402	956
Continuous track circuit	296	496
Electric train staff....	401	414
No. of block signal stations.... 10,609		
Closed part of the time 4,400		
Permissive signaling forbidden	7,597	9,330
Permissive signaling allowed, by 3-pos. signal	23,999	29,590
By 2-pos. signal and flag or lamp	950	1,095
By caution card.....	26,476	29,214
Rear-end protection....	8,578	8,697

The Diesel Locomotive: Reasons for the Slow Adoption of Diesel Engines in the United States

From time to time during the past two years, reports have appeared in the foreign technical journals that the Sulzer Brothers' Works, at Winterthur, Switzerland, were engaged upon the construction of a locomotive to be propelled by Diesel oil engines. The first official statement concerning the design of this locomotive was made on Apr. 30 by Dr. Rudolph Diesel in his address before the Gas Power Section of the American Society of Mechanical Engineers in New York City.

A special meeting of the Society was held in the auditorium of the Engineering Societies' Building, on the evening of Tuesday, Apr. 30. At the opening of the meeting, the distinction of honorary membership in the Society was formally conferred upon Doctor Diesel by the President of the Society, Dr. Alex. C. Humphreys, of Stevens Institute. After expressing his high appreciation of the honor conferred, Doctor Diesel then addressed the members of the Society on the development of the Diesel engine. For the most part, his address covered much the same ground as his address before the Institution of Mechanical Engineers of Great Britain, which was printed in our issue of Apr. 4.

Near the close of his lecture, however, Doctor Diesel gave some account of his work in the design of the Diesel locomotive. This portion of his address we reprint, as follows:

Of the Diesel locomotive nothing has been published yet, and it is a special pleasure to me to give here, in this country of mighty oil wells and gigantic railways, my first description of the first Diesel locomotive ever made.

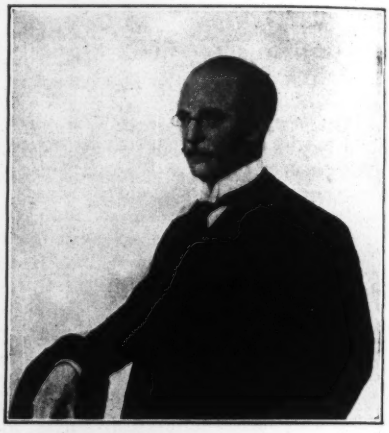
From the early days of my invention I was of the opinion that the special features of the Diesel engine would be of even greater importance for transport purposes than for stationary work. I have already mentioned that I built the first small marine engine in 1902 and that since that time the Diesel marine engine has been developed without interruption. I further mentioned that I made the first automobile engine for trucks in the year 1899, and I look forward to the development of this branch within a few years. Finally, I have to say that I have worked for the past five years, together with Sulzer Bros., at Winterthur, and Adolph Klose, of Berlin, on the construction of a Diesel locomotive, and that the first express-train locomotive of 1000 to 1200 hp. was finished a few weeks ago, and is now on the testing bed in the Winterthur shops.

Five years is a very long time, and to explain why the work has taken so long, I must mention that the locomotive is the most difficult problem of construction that can be taken up in the way of modern engine building, not only on account of the difficulties in starting and maneuvering with this special kind of motor, but also on account of the excessive limitations as to space and weight. Compared with this, the development of the reversing marine motor has been relatively simple.

The accompanying cut shows the design of this locomotive, the car of which was made in the locomotive works of A. Borsig, at Berlin. It is 16.6 meters long over the buffers and has two four-wheel trucks, and two pairs of driving wheels. The latter are not directly coupled to the Diesel engine, but indirectly by means of the jackshaft 3, which is the crankshaft of the Diesel engine 4.

The Diesel engine is an ordinary two-stroke cycle engine with four cylinders coupled in pairs at an angle of 90° and driving the jackshaft, the cranks of which are at an angle of 180°. This arrangement gives complete balancing of the moving masses, the first and most important condition when placing such engines on a movable platform.

Between the working cylinders are placed two scavenging air pumps 5 driven by levers from the connecting rod. Beyond the engine in the roof of the car is placed the muffler 6. On the right of the main engine stands an auxiliary engine 7. This latter consists of two vertical two-stroke cycle Diesel cylinders 7-7 coupled to horizontal air pumps 8-8 driven by these cylinders. The cooler for the air compressed by these pumps is shown at 9. These air pumps serve, according to a special and patented process, to increase the power of the main engine when starting, maneuvering and going up grade in such a way that auxiliary compressed air and auxiliary oil fuel are conducted into the main cylinders, by which means the indicator diagram is enlarged, which makes the engine as elastic as a steam engine.



DR. RUDOLPH DIESEL, INVENTOR OF THE DIESEL ENGINE

In the ordinary running of the locomotive, the main cylinders work like ordinary Diesel engines without the help of the auxiliary.

To the right of the main engine is placed a battery of air reservoirs 10, which help the action of the auxiliary engine and which can be refilled by the auxiliary engine at times when the latter is not in use to help the main engine. Two pumps 11 and 12 provide for the water circulation in the cylinder jackets; 13 indicates an apparatus for the cooling of the jacket water by evaporation, and 14 the tanks for fresh water and for fuel; 15 is a small donkey boiler for the heating of the train.

The passages 16 under the roof lead the fresh air to the suction pipes of the different motor and pump cylinders.

The whole plant is contained in a closed engine room which makes the locomotive look from the exterior like one of your steel cars.

The engine runner can operate the machine equally well from either end of

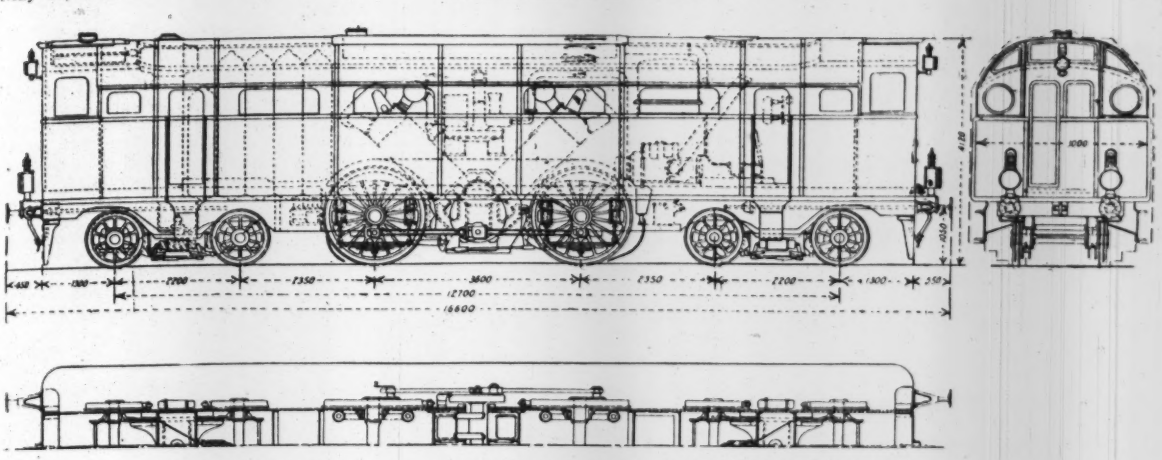


FIG. 2. LONGITUDINAL AND CROSS-SECTIONS OF THE DIESEL LOCOMOTIVE

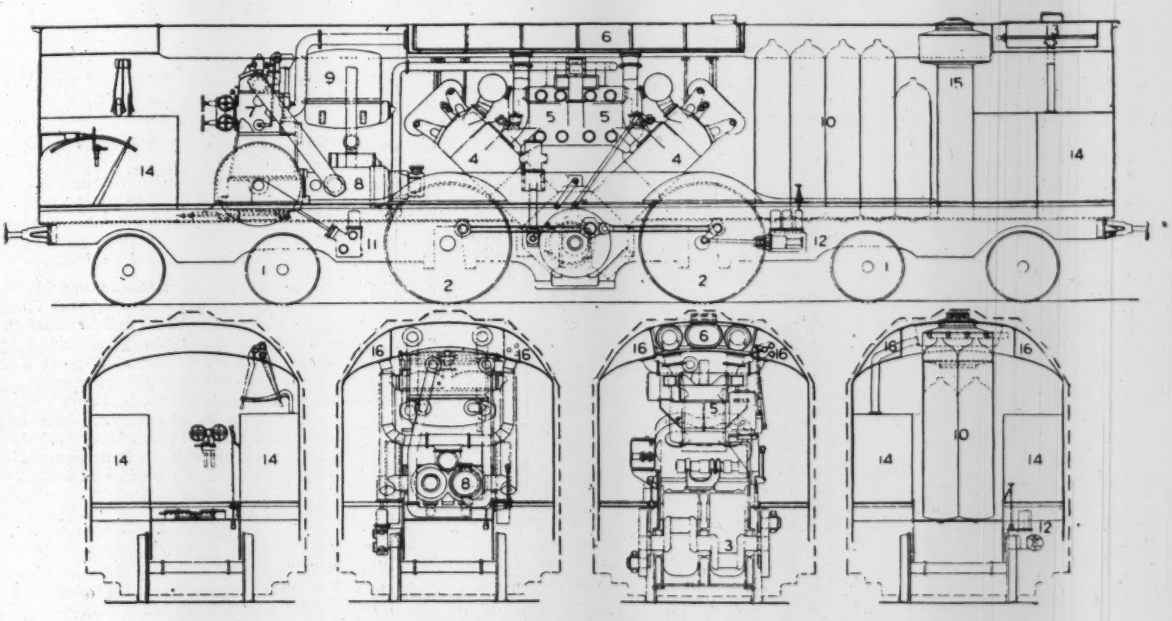


FIG. 3. SECTIONAL ELEVATION, END VIEW AND HALF PLAN OF THE DIESEL LOCOMOTIVE

(Cuts reproduced from a print furnished by the courtesy of the Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis.)

the locomotive, as the engine is arranged for running in both directions. He has a direct view of the track. Doors and platforms lead from the engine to the train.

The total weight of the locomotive ready for service is 85 tons.

I cannot predict whether this attempt at an entire revolution in the working of railways will be successful at the first attempt, or whether it must be repeated; but one thing is certain to me: The Diesel locomotive will come, sooner or later, according to the perseverance with which the problem is followed.

THE DIESEL ENGINE IN AMERICA

Before concluding my lecture I should like to touch on one very important question which has been put to me by the Secretary of the United States Navy, to whom I paid my first visit on coming to this country, and which has been repeated to me nearly every day since I left the pier at Hoboken: "Why are we in America so far behind Europe in the development of this new prime mover, which in fact is no longer new today?"

In answering this question, I must emphatically state that the Diesel engines built in this country, after having passed the necessary manufacturing apprenticeship more than ten years ago, have been and are quite as good as our European machines. Hence the question is not a technical one, but merely a commercial one or, even more, one of the general economic conditions in this country. I do not know the United States sufficiently to judge these conditions on my own behalf, but I have tried to find out in my conversations with many of your prominent engineers, and the following is what I learn:

First—Coal is much cheaper than in Europe, and therefore, people are more wasteful of it. While the leading idea in Europe is always economy in operating cost, the leading idea in America is economy in first cost. The word *efficiency*, which is the base of every contract with us, seems to be unknown to a vast proportion in this country; not, of course, unknown to engineers, but to business men and buyers of engines.

Second—In the same order of ideas, your steam engines are much cheaper than ours. But the Diesel engine is not and will not be a cheap engine; it aims to be the best engine and must be constructed of the highest class material, with the best tools and by the most skilled workmen. This makes it difficult

for it to compete where such ideas, as I said before, are prevalent.

The people here are accustomed to very low prices of engines, figuring on the price per pound; and the price of Diesel engines per pound seems to them exorbitant. Several people have said to me that they would never buy an engine at that high price per pound, even with a guarantee that the whole plant would repay its cost by the savings of a few years only.

Third—Another general reason seems to be in very many cases the lack of capital of the prospective purchaser, and also in many cases the higher rate of interest prevailing in the American money markets.

Fourth—A further reason is this: That in the last few decades the general profits of business have been so big that people did not care for the most economical methods of production and for the strictest economy in the fuel bill as well as other expenses. The ruling object has been to manufacture quickly and in great quantities without regard to the cost. You had not, as we have in Europe, to compete with the other industrial countries of the world.

I have been told by American engineers that what has happened to the Diesel engine has also happened to the large gas engine, especially those using blast-furnace gases, and also the steam turbine, both of which machines were not taken up in this country until long after their development in Europe. The same thing has happened with the byproduct coke oven. Even today, the wasteful beehive oven is largely in use in America, while in Europe, the industries built up been built up by utilization of the valuable byproducts produced in coke manufacture earn hundreds of millions of dollars every year, and have had a tendency to keep prices of the natural liquid fuels on a lower level.

All the conditions I have alluded to seem to be changing rapidly now. This terribly wasteful performance begins to be recognized. Competition has become more keen, and the conservation of natural resources is being striven for more than ever before. If this is true, high-class engines with the highest fuel efficiency will begin on this side of the ocean to have the same importance as abroad.

In conclusion, I express the hope that I have succeeded in giving to you a true and clear picture of the development of the Diesel engine in our old Europe, with a few reminiscences of the pioneer work in America. And I must call to your mind the fact that nowhere in the world are the possibilities for this prime mover as great as in this country. I think you for giving me this opportunity to thoroughly acquaint with these facts, this chosen circle of your industrial leaders and foremost engineers.

A Locomotive Axle Broke, May 7, and caused the wreck of train No. 31 on the Southern Ry., near Columbia, S. C. Twenty persons were injured. The train had six cars. The first three were derailed, but remained upright. The last three were overturned.

An Oil Barge Fire and explosion, at Cleveland, Ohio, May 1, destroyed two barges belonging to the Standard Oil Co., and one tug owned by the Great Lakes Towing Co. Five men were killed. The fire started while Barge 88 was being loaded with gasoline from a 10,000-gal. tank on shore. The flaming oil spread over the surface of the river, setting fire to the docks and a number of nearby vessels. The men killed were caught by the flames while at work on another barge alongside No. 88.

An Explosion at one of the furnaces of the American Steel & Wire Co., at Cleveland, Ohio, May 8, killed a number of workmen. Reports state that the accident occurred when the furnace was being cleaned out preparatory to closing down.

Wind Caused a Bridge Accident on April 26, 1912, at Fort William, Ont., where a bridge over the Kaministiquia River was being erected for the Canadian Pacific Ry. Several girders of the highway deck of the bridge, which had just been set in place but were not yet riveted, fell during a windstorm. The damage is reported to be small.

The Mississippi River Flood Situation appears to be somewhat improved this week. On May 14 the U. S. Weather Bureau reports the river about stationary with a slight rising tendency above St. Louis and falls of about 0.1 ft. at stations south of Vicksburg. It is predicted that the river will change a little, but will probably fall slowly throughout the month of May. The following table gives the stages of the river on each of the past four Tuesdays:

	Apr. 23	Apr. 30	May 7	May 14
Cairo	44.8	45.5	48.8	43.8
Memphis ...	39.9	36.8	38.0	38.2
Helena	54.2	51.3	48.5	48.9
Arkansas City	52.9	52.1	51.5	50.8
Greenville..	46.8	45.6	44.9	44.2
Vicksburg..	48.4	47.9	48.4	47.9
Natchez ...	50.1	49.7	50.8	50.7
Donaldsonville	32.2	....	34.3	34.6
Baton Rouge	....	41.5	43.2	43.7
New Orleans	20.2	20.4	21.2	21.3

At 2 a.m., on May 11, the highest stage in the river, 22.0, was reached at New Orleans, but this dropped to 21.4 by 7 o'clock that same morning. The levees during the past week all held except one near Nestor, La., 55 miles below New Orleans, where a break occurred which may damage the oyster beds there.

The Manhattan Bridge Profit Suit, whose decision was noted in our issue of Apr. 18, 1912, p. 750, resulted in a jury verdict for some $300,000 in favor of Cornelius J. Sullivan and against the Ryan-Parker Construction Co. That verdict has now been set aside by the trial judge. The chief reason given for this action was that the verdict was excessive, being considerably greater than the financial testimony offered at the trial warranted.

Dry Dock No. 4, at the Brooklyn U. S. Navy Yard, has finally been completed after seven years' labor, during which three different contractors have successively taken over the contract. The dock is of concrete construction, 695 ft. long, 139 ft. wide and 31½ ft. deep, providing dockage for the largest naval vessels now contemplated. The contract for its construction was first let in 1905 to George Spearin, but the immense difficulties in foundation construction resulting from the soft bottom encountered, caused that firm to abandon the job, and in 1907 it was relet to the Williams Engineering Co. Soon after, when only 15% of the work had been completed, that firm, too, was forced to abandon the contract. It was then thought that the Government would have to continue the work by day labor, but this was decided against and bids were asked for the completion of the work from private companies, plans for its prosecution to be submitted with the bid. Under this arrangement the contract was awarded in October, 1909, to Holbrook, Cabot & Rollins, of Boston, Mass. This firm carried the construction to a successful conclusion, and on May 10, 1912, it was emptied to allow the docking of the 22,000-ton U. S. battleship "Utah." The operation proved successful. The original appropriation for the construction was $1,500,000, of which $240,000 was expended in the first two attempts at construction. The final bid was $1,390,000, which was subsequently increased to $2,750,000.

Panama Canal Excavation during April totaled 2,754,383 cu.yd., a daily average of 110,175 cu.yd. for each of the 25 working days. Rainfall for the month was 2.35 in. The amount of concrete laid in April was 122,187 cu.yd., and 584,822 cu.yd. of fill was placed in dams.

A Special Panama Excursion for members of the 12th International Navigation Congress, to be held in Philadelphia, Penn., May 23-28, is proposed by the Philadelphia Commercial Museum. If a number of members approaching 100 agree to go on this excursion a special steamer may be chartered. The trip is planned to take about three weeks' time, and all expenses, including several days on the Isthmus, need not exceed $175. It is proposed to leave New York between June 17 and 19. Foreign delegates not wishing to return to New York may take advantage of the exceptionally low rate of $45 for one way on the Panama R.R. S. S. Line and return to Europe direct from Colon.

The Steamship "France," the newest transatlantic liner of the Compagnie Generale Transatlantique, reached New York on her maiden voyage from Havre on Apr. 26. She is the largest and fastest steamer ever built in French yards or by French engineers. Her general dimensions are as follows:

Length over all	713 ft.
Length bet. perpendiculars	684 ft.
Max. width	75.5 ft.
Displacement	30,000 tons
Engine power	39,500 hp.
Required speed	24½ knots

The listed capacity is 2526 persons, as follows: first cabin, 534; second cabin, 442; third cabin, 950; officers and crew, 600. The ship is divided by 13 transverse bulkheads into 14 watertight compartments, which extend up to the top deck forward, but only to lowest deck above water line amidships. In addition longitudinal compartments are provided in the boiler room by the coal bunkers, which are outside and above that room. The usual standard of flotation, viz, with two successive compartments flooded, is preserved.

The "France" is driven by triple expansion turbines acting on four screws.

Forward motion is assured by four turbines, one high pressure, one intermediate and two low pressure, each working on a separate shaft carrying a screw. Reverse motion is assured by two high-pressure turbines and two low-pressure turbines, the two latter being in the same casings as the forward motion low-pressure turbines on the middle propeller shafts, and the former on the two outer propeller shafts. These high- and intermediate-pressure turbines are separated from the low-pressure ones by a transverse bulkhead.

The ship was built at the "Chantiers de Saint Nazaire." In a trial trip it made a 24-hour run at an average of 25 knots.

Transatlantic Steamship Routes have been shifted 60 miles still further south, as a result of the unprecedented prevalence of icebergs. On Apr. 19, following the wreck of the "Titanic," the summer routes were shifted about 160 miles south of the latitude in which the wreck took place. The position of these routes was shown in our issue of Apr. 25, p. 805. On May 12, the new agreement was made by the various steamship lines and the westbound route (which is some 50 miles north of the eastbound) is now laid out to cross longitude 45° and 50° in latitude 38° north. This will increase the time for crossing by some three hours over that for the routes of Apr. 19, or about nine hours more than for the route on which the "Titanic" was sunk.

The Berlin Tunnel, which is to carry the underground railway beneath the river Spree, is being built in open cut within cofferdams, and the work has been divided into two sections. The length of the river crossing, exclusive of approaches built in open cut, is about 430 ft. Half the width of the river was first closed by two parallel cofferdams 75 ft. apart and an end cofferdam at the middle of the river. The enclosed space was excavated and drained, and the double-track reinforced-concrete tunnel of rectangular section was then built. A second end cofferdam or bulkhead was then built back of the first one, the two (with the side walls connecting them) forming a pit around the head of the tunnel, which was closed by a temporary concrete bulkhead wall. The cofferdams from the shore were then removed, and similar cofferdams built from the opposite shore to the island cofferdam left in place at the middle of the river. This second enclosed space was then pumped out and excavated, and the second portion of the tunnel built.

The work has been delayed by an accident which occurred Mar. 27. Apparently one corner of the end cofferdam had been scoured by the current, so that water broke through and flooded the pit. The pressure also burst the concrete bulkhead closing the river end of the completed tunnel (assisted probably by cracks due to undermining of this end of the tunnel) so that this portion also was flooded. There was no loss of life, and by Apr. 2 the breaks had been closed and the flooded tunnel and excavation pumped out so that work could be renewed. This plan of building a river tunnel in two portions in open cut was proposed for the La Salle St. tunnel at Chicago, as noted in our issue of Jan. 12 and Apr. 13, 1911, but the government engineers would not permit the closing of the river channel for half its width. The alternative adopted in this case, therefore, was to build a steel and concrete shell, which was floated into place and sunk, on the same general principles as the Detroit River tunnel construction.

The failure of the cofferdam is now attributed ("Zeitschrift des Vereines deutscher Ingenieure," May 4, 1912) to scour under the outer end of the completed half of the tunnel. The action of the river is alleged to have removed enough soil from under the tunnel to permit the end to sag and crack the tunnel across, admitting water in large volumes, both into the finished length of tunnel (and thence to the low-lying parts of the subway) and into the cofferdammed pit for the second half of the tunnel.

Yuma Tunnel Under Colorado River—On May 3 the top heading of the Yuma tunnel under the Colorado River was holed through, making connection with the shaft on the California bank. The difficult enterprise has been brought to this stage of completion with loss of only one life.

The tunnel is to be an inverted siphon for carrying irrigation water from the main irrigation canal on the California bank to the Arizona distributing canal system, watering 90,000 acres. The tunnel is 15 ft. in diameter inside, and is about 1000 ft. long; its greatest depth below the river surface is about 100 ft. The material penetrated is a soft, pervious sandstone. Compressed air was used. The work is under the U. S. Reclamation Service.

Bridge Terminal Development is much to the fore at present in New York City. A broad-gage plan for the development of the east entrance to the Manhattan Bridge has been prepared by the Department of Bridges of the city. It includes proper provision for pedestrian and roadway traffic, besides provision for trolley, subway and elevated-railway connections. A plaza is laid out at the branching of the several ways of communication, and this is parked and beautified as fully as space permits. The plans for the reconstructed entrances to the Brooklyn Bridge were shown in our issue of May 9, 1912.

Personals

Mr. J. E. Stubblefield has been appointed Superintendent of the Texas State R.R., succeeding Mr. L. A. Daffan, resigned.

Mr. John B. Truman, for the past seven years City Engineer of Lafayette, Ind., has become associated with F. Mertens Sons, of Cumberland, Md.

Mr. E. A. Probst has been appointed Division Engineer in charge of construction of the Southern New England Ry., from Palmer to Blackstone, Mass.

Mr. T. I. Ellis has been appointed Division Engineer in charge of construction of the Southern New England Ry., from Providence to Woonsocket, R. I.

Mr. Lewis A. Riley, President of the Lehigh & Hudson River R.R., has been elected President of the Lehigh & New England R.R., succeeding the late W. A. Lathrop.

Mr. E. N. Zern, Professor of coal mining at the University of Pittsburg, Penn., has been appointed Professor of mining engineering at the West Virginia University, Morgantown, W. Va.

Mr. J. P. Kavanagh, Assistant Superintendent of the Baltimore & Ohio Southwestern R.R., at Cincinnati, Ohio, has been made Superintendent of Terminals of the Baltimore & Ohio R.R., at Baltimore, Md.

Dr. Henry M. Payne, a consulting mining engineer of New York City, has become associated with Stephen T. Williams & Staff, of 346 Broadway, New York City, as Mining and Metallurgical Specialist.

Mr. F. W. Peters, Assistant to the Vice-President of the Canadian Pacific Ry., at Vancouver, B. C., has been appointed General Superintendent of the British Columbia division, succeeding the late James Oborne.

Mr. J. C. Pinney, Jr., Instructor in bridge engineering at Marquette University, Milwaukee, Wis., has been appointed Superintendent of bridges and buildings of the city of Milwaukee, at a salary of $2200 per annum.

Mr. Cecil N. Haggart, Assoc. M. Am. Soc. C. E., has resigned as Bridge Designer, office of the New York State Engineer, Albany, N. Y., and will open an office at 702 Columbia Bank Bldg., Pittsburg, Penn., for the practice of structural engineering.

Mr. R. Winthrop Pratt, M. Am. Soc. C. E., of Cleveland, Ohio, has been employed to report on a joint sewage disposal plan for the boroughs of Beaver, Beaver Falls, New Brighton, Rochester, New Rochester, College Hill and Patterson Heights in Pennsylvania.

Mr. A. R. Brown, Jun. Am. Soc. C. E., until recently in the Assistant Chief Engineer's Office at Culebra, Panama Canal, has accepted an appointment in the engineering department, Board of Water Commissioners of Hartford, Conn., under Mr. C. M. Saville, M. Am. Soc. C. E., Chief Engineer.

Mr. Leonard Day, Assoc. Am. Inst. E. E., has been appointed Electrical Engineer in charge of the fire-alarm telegraph bureau of the New York City Fire Department at a salary of $5000 per annum. Mr. Day is a graduate in electrical engineering of the Worcester Polytechnic Institute and has been practicing as a patent attorney for a number of years.

Mr. John Purcell, Superintendent of Shops of the Atchison, Topeka & Santa Fé Ry., at Topeka, Kan., has been appointed Assistant to the Vice-President in charge of operation, at Chicago, Ill. The office of Superintendent of Motive Power has been merged with that of the Vice-President in charge of operation, and Mr. Purcell will have charge of all matters in the mechanical department.

Messrs. Wm. S. Logan and Gerardo Immediato, Assoc. Ms. Am. Soc. C. E., have formed a partnership under the firm name of Logan & Immediato, for the general practice of civil engineering and surveying, with offices at 9 Clinton St. Newark, N. J., and the Plaza Bldg., Montclair, N. J. Mr. Logan was formerly City Engineer of Summit, N. J., and Mr. Immediato has been Town Engineer of Montclair.

Messrs. Walter G. Kirkpatrick, M. Am. Soc. C. E.; Massena L. Culley, Jun. Am. Soc. C. E.; John E. McCorkle, Jr., and John R. Baylis have formed a partnership under the firm name of Kirkpatrick, Culley, McCorkle & Baylis, for the general practice of engineering, with offices at 703 Farley Bldg., Birmingham, Ala. Mr. Kirkpatrick is Chief Engineer of the

city of Birmingham, and will serve the new firm as a consulting engineer.

Mr. F. F. Busteed, M. Can. Soc. C. E., until recently General Superintendent of the Canadian Pacific Ry., at Vancouver, B. C., is now Engineer in charge of grade revision and double-tracking from Calgary west, with headquarters at Kamloops, B. C. Mr. Busteed is an engineering graduate of McGill University and served in the engineering department of the Canadian Pacific Ry. for 22 years before entering the operating department in 1903. From 1904 to 1907 he was Assistant Chief Engineer of the western lines.

Mr. Richard L'Hommedieu, General Manager of the Michigan Central R.R., has resigned. Mr. L'Hommedieu entered the railway service in 1870 as an apprentice in the locomotive machine shops of the Cincinnati, Hamilton & Dayton Ry., at Cincinnati, Ohio. Two years later he was a clerk in a division superintendent's office of the Chicago, Burlington & Quincy R.R. In 1873 he was appointed to the position of trainmaster on the Michigan Central R.R., and was promoted through the operating department to his present position in 1903.

Mr. C. C. Riley, Assistant to the General Manager of the Baltimore & Ohio R.R., at Baltimore, Md., has been appointed General Superintendent of Transportation, succeeding Mr. H. B. Voorhees, whose promotion is noted elsewhere in these columns. Mr. Riley was educated as a physician, but entered the operating department of the Cleveland, Cincinnati, Chicago & St. Louis R.R. in 1888, and at the end of ten years was Superintendent of Car Service. Since then he has served in the operating departments of several railways in the Middle West.

Mr. H. B. Voorhees, formerly General Superintendent of Transportation of the Baltimore & Ohio R.R., at Baltimore, Md., has been appointed General Superintendent of the Baltimore & Ohio Southwestern R.R., at Cincinnati, Ohio. Mr. Voorhees graduated in civil engineering at the Rensselaer Polytechnic Institute when he was 20 years old and began his railway career in 1897 as an assistant supervisor in the engineering department of the Philadelphia & Reading R.R. For two years, 1901 to 1903, he was Assistant Engineer and Division Engineer of the Baltimore & Ohio R.R., afterward entering the operating department.

The Intercolonial Ry., which is owned and operated by the Canadian Government, has created the new position of Assistant Superintendent for each of its four districts. The following appointments to this position have been made: Mr. E. L. Desjardins, to the Montreal district; Mr. L. S. Brown, to the Moncton, N. B., district; Mr. Y. R. Colclough, to the Halifax district, and Mr. W. A. Fitch, to the Sydney, C. B., district. Mr. Thomas McPherson, formerly Roadmaster of the Intercolonial Ry., at New Castle, N. B., has been appointed General Roadmaster of the Intercolonial and Prince Edward Island Rys., with headquarters at Moncton.

Obituary

John A. Shanahan, a civil engineer and former Division Engineer of the San Pedro, Los Angeles & Salt Lake Ry., died at Salt Lake City, Utah, on May 12, aged 40 years. He is survived by a widow and two children.

Lawrence H. K. Chipman, an engineer in charge of a locating party of the Edmonton, Dunvegan & British Columbia Ry., was drowned in the Athabaska River near Mirror Lake, Alberta, on Apr. 7. It is believed he lost his life while attempting to cross the stream on the ice.

Horace B. Bannard, Engineer of Maintenance-of-Way of the New York & Long Branch R.R., died at his home in Asbury Park, N. J., on May 10. He was a brother of Wm. N. Bannard, for many years Superintendent of the Maryland division of the Philadelphia, Wilmington & Baltimore R.R.

Engineering Societies

COMING MEETINGS

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 22-25. Annual convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

INTERNATIONAL NAVIGATION CONGRESS.
May 23-28. At Philadelphia, Penn. Secy., J. C. Sanford, 344 The Bourse, Philadelphia, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 28-31. Spring meeting at Cleveland, Ohio. Secy., C. W. Rice, 29 West 39th St., New York.

AMERICAN WATER WORKS ASSOCIATION.
June 3-8. Annual convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N. Y.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 4. Annual convention at New York City. Secy., P. W. Drew, Soo Line, Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 10-14. Annual meeting at Seattle, Wash. Secy., T. C. Martin, 29 West 39th St., New York.

MASTER CAR BUILDERS' ASSOCIATION.
June 12-14. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

CANADIAN ELECTRICAL ASSOCIATION.
June 19-21. Annual meeting at Ottawa, Ont. Secy., T. S. Young, 220 King St., West, Toronto, Ont.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 25-28. Annual convention at Boston, Mass. Secy., F. L. Hutchison, 33 West 39th St., New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 25-28. Annual convention at Seattle, Wash. Secy., C. W. Hunt, 220 West 57th St., New York.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 26-28. Annual meeting at Boston, Mass. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS.
June 27-29. Summer meeting at Detroit, Mich. Secy., C. F. Clarkson, 1451 Broadway, New York.

NATIONAL MUNICIPAL LEAGUE.
July 8-12. Annual meeting at Los Angeles, Calif. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 11-12. Summer meeting at Detroit, Mich. Secy., W. W. Macon, 29 West 39th St., New York.

OHIO ELECTRIC LIGHT ASSOCIA[TION]
July 16-19. Annual conventi[on] Cedar Point, Ohio. Secy., D. L. [Mc]kill, Greenville, Ohio.

Ohio Engineering Society—The [next] annual convention will be held at C[olum]bus, Ohio, in the Great Southern H[otel], Jan. 21-23, 1913.

Pacific Northwest Society of Engineers—In view of the fact that the American Society of Civil Engineers will hold its annual convention in Seattle, on [July] 25-28, the Pacific Northwest Society is not planning to hold any convention this year.

American Chemical Society—A Maine section of this society is to be organized at a meeting to be held in Fernald Hall of the University of Maine at Orono, on May 16. Preceding the organization meeting, a technical session will be held devoted principally to the pulp and paper industry.

American Association for Labor Legislation—The second national conference on industrial diseases will be held at Atlantic City, N. J., June 3-5, with headquarters at the Hotel Marlborough. This will be a joint session with the American Medical Association. In connection with the conference there will be an industrial hygiene exhibit, which will include photographs and charts showing the effect of occupational diseases.

Ohio Society of Mechanical, Electrical and Steam Engineers—The business sessions of the 25th meeting at Pittsburg, Penn., May 16-18, will be held at the rooms of the Engineers Society of Western Pennsylvania in the Oliver Bldg. on Thursday, and at the Carnegie Technical School on Friday and Saturday. Three papers are to be presented, as follows: "Combustion of Coal in Relation to Boiler Economy," E. A. Uehling, Passaic, N. J.; "Modern Incandescent Lamps; Electrical, Photometric and Economic Characteristics," Ralph Beman, Cleveland, Ohio; "Transformers and Transformer Connections Frequently Met in Practice," Francis Gangl.

International Congress of Navigation—Foreign engineers representing 30 different governments will be present at the 12th congress which opens May 23 at Philadelphia, Penn. Almost every transatlantic liner arriving in this country in the next two weeks will bring parties of delegates to this congress. The "Berlin" of the North German Lloyd line brought the first large party on May 14, including many of the Italian delegation. On the 17th, the "Mauretania" will bring several of the delegates and on the 18th, the "Lorraine" will bring the greater number of the French delegation. The Belgium delegation, with a few exceptions, will arrive on the "Kroonland," May 20. On the same day the "Rotterdam" will bring the delegates from Holland and the "Kaiser Wilhelm II" will bring the Russian delegation. The largest party, including 31 of the German delegation, will arrive on the "Friedrich Wilhelm der Grosse." The sessions will be classified into two sections, on inland navigation and ocean navigation respectively. In the ocean section, the topic of safety of navigation will be brought up and will be given special attention because of the interest aroused by the "Titanic" disaster.

Engineering Literature

CONTENTS

EDITORIAL 947
CORRESPONDENCE:
A Question of Credit: Chas. Warren Hunt; L. C. Wason 947
On the Review of Hartmann's Heat and Thermodynamics"; F. M. Hartmann; L. S. Marks 948
Comments on the Review of "The Elements of Structures"; G. A. Hool; Robert Fletcher 949
REVIEWS:
Thermodynamics of the Steam Turbine. By H. E. Longwell 949
Electric Ignition for Combustion Motors 951
Efficiency as a Basis for Operation and Wages—The Twelve Principles of Efficiency 952
A Short Course in Graphic Statics. By Henry S. Jacoby 953
Practical Sewerage and Sewage Disposal 953
Laboratory Manual for the Use of Students in Testing Materials of Construction 953
Steam Power Plants 953
Elementary Mechanical Refrigeration. By Reginald P. Bolton 954
Who's Who in Science 954
Standard Forms of Field Notes for Civil Engineers 954
Experimental Engineering and Manual for Testing 955
Engineering Directory 955
The Essentials of Lettering 955
Storage Batteries—Die Krankheiten des Stationaeren Elektrischen Blei-Akkumulators—Alternating Current Design. By Henry H. Norris 956
Essential Points Governing the Financial Value of an Engineering Property 957
The American Government 957
Refrigeration, Cold Storage and Ice Making. By J. C. Bertsch 958
Text-Book of Cyanide Practice. By F. W. Traphagen 959
Observations Upon the Natural History of Epidemic Diarrhoea 959
Reinforced Concrete Buildings 960
Flood Commission of Pittsburg, Penn 960
The Law of the Employment of Labor; Attitude of American Courts in Labor Cases 961
PUBLICATIONS RECEIVED 962

EDITORIAL

The many engineers who have been awaiting the publication of George W. Fuller's comprehensive treatise, entitled "Sewage Disposal," will be pleased to know that it will be available in a few days. A notice of the volume will appear in a later issue. The publisher is the McGraw-Hill Book Co.

Weekly and even daily papers published by municipalities and more or less worthy of the name newspapers have been issued in various parts of the United States for some years past. Most of these are dry-as-dust affairs made up chiefly of official reports of the proceedings of the city council and various other municipal bodies or committee, together, in some instances, with advertisements for contract proposals. A newspaper of quite a different sort has been established by the City of Los Angeles, Calif. The first number appeared on Apr. 17. For the present, at least, the newspaper will be a weekly. It is called the *Los Angeles Municipal News* and has as subtitles "A newspaper owned by the people" and "City business is your business." The *Municipal News* is filled from beginning to end with articles and items relating to various phases of municipal undertakings and politics, some of which are illustrated. It carries a large amount of advertising. Direct legislation ordinances to be voted on by the people in the future are printed in synopsis, followed by arguments by proponents and opponents.

CORRESPONDENCE

A Question of Credit

Sir—In your issue of Apr. 18, 1912, p. 755, you printed an article entitled "A Bibliography of the Corrosion of Iron and Steel in Cinder Concrete," by Morton C. Tuttle, Secretary of the Aberthaw Construction Co., Boston, Mass.

The article states that this bibliography, "which is practically a complete one, has been compiled in the course of an investigation of that subject," and that "a variety of topics is treated in the 31 articles listed," and names a number of them. Also that "these references are from American, French, English, and German publications," and result from an examination of a number of periodicals, which are all named.

The bibliography which follows is an exact reproduction (except that a few minor explanatory notes giving numbers of books and length of articles, etc., are omitted) of a search made in this office at the request of Leonard C. Wason, a member of this society, and forwarded to him under date of Jan. 12, 1912. All of the books and articles listed are in the library of this society, and the examination of them above referred to was made here by its employees.

There was no intimation that the bibliography was to be published and, in my opinion, publication was improper without a statement of the facts.

Further comment does not appear to be necessary, but I respectfully ask that you publish this letter in your journal, so that Mr. Tuttle will not be credited with having made a research which was made by the library of this society.

CHAS. WARREN HUNT, Secretary
American Society of Civil Engineers.
New York City, Apr. 23, 1912.

Sir—The article mentioned in the foregoing letter from Mr. Hunt was addressed to you in the form of a letter on our company letterhead. The name, Morton C. Tuttle, appeared merely as the signature of the writer of the letter beneath the name of the company. The letter was not presented as a contributed article. There was no thought of indicating or suggesting that this bibliography was prepared either by the company or by Mr. Tuttle. It was merely stated that it had been "compiled in the course of an investigation." There was no intention to suppress the name of the American Society of Civil Engineers, and it is equally true that it was not thought necessary to even give credit for the source of the information.

In explanation of the article in question, I desire to say that sometime since we undertook a somewhat critical study of this subject. As a step in securing the desired information a note was sent to various engineering papers stating that the Aberthaw Construction Co. would be pleased to hear from any one "who has practical experience or possesses information on this subject." As another step the American Society of Civil Engineers, of which the writer is a member, was requested to make a search and report references to current literature relating to this subject. This work was done in accordance with the usual practice of the society, a charge was rendered for the same, and the bill was paid by the Aberthaw Construction Co. Both Mr. Tuttle and myself, who are, respectively, secretary and president of this company, very naturally treated this material exactly as we would the report of any other investigation made at our request by one of our own staff or by an independent expert and paid for by us. In a word, we considered it to be our own property to utilize as we pleased.

Having previously had occasion to investigate an entirely different subject, and having reported that investigation through the columns of an engineering paper, to the evident gratification of its editor and its readers, we felt that this matter might be treated in a similar way with equal advantage to the engineering profession. That we should have secured permission to reveal to others the contents of this report never entered our heads.

As a member of the society I feel very strongly that its usefulness will be distinctly limited if the rule should prevail that all information secured in this way must be considered confidential by the party who pays for it. If it represented other than mere clerical work in the matter of examining publications and reporting upon their contents there might possibly be some question as to the ethics of the case. I trust, however, that the integrity of our purpose having been established there may be also established a broader recognition of the possible use-

fulness of the society to its members and the public at large.

We shall welcome a thorough discussion of this matter in your columns. But we trust that it will be confined to what really seems to be the point at issue —that is, whether it is proper to publish information so secured and paid for unless permission is secured or full credit is given.

As it was not Mr. Tuttle's intent to claim personal credit for the compilation, I trust that this fact may be clearly understood.

L. C. WASON, President,
Aberthaw Construction Co.

Boston, Mass., Apr. 29, 1912.

[We credited Mr. Tuttle with authorship of the article in accordance with our custom to give credit and to fix responsibility for matter not prepared by some member of our staff. Proof of the article, as published, was approved by Mr. Tuttle.

Further than the points covered in the foregoing statements, the questions at issue seem to be: (1) Is the author of an engineering report or of an article for an engineering paper under obligations to give specific credit for paid clerical assistance rendered in the course of his investigations? (2) Is the case any different where the paid clerical service is rendered by an engineering society to one of its members?

While we agree with Mr. Wason that the second question, having been raised so pointedly by Mr. Hunt, merits discussion, yet the space we can devote to it is, for obvious reasons, small. It seems to be chiefly a matter of relationship between the society in question and its members.—ED.]

On the Review of Hartmann's "Heat and Thermodynamics"

Sir—Permit me to reply to the review of my book, "Heat and Thermodynamics," which appeared in your issue of Apr. 18.

The manner in which the reviewer, Prof. Lionel S. Marks, criticizes my work makes it very difficult to reply, since, in the main, his criticisms are merely arbitrary statements as though he were the court of last resort on all matters pertaining to thermodynamics.

The reviewer appears to forget that the book was written for students, and not for professors of engineering, and though the derivation of equations may be too "painfully complete" to suit Prof. Marks, I have yet to find a student to whom it is *painful* to have an argument presented to him in its entirety. Why should we worry a student by requiring him to find the intermediate steps in algebraic transformations when we are, at the same time, expecting him to acquire new ideas in physics?

Whether line diagrams are helpful to a student or not, is a matter of personal opinion; but, one has only to examine the illustrations in standard books on electrical engineering to realize that line diagrams are the all-essential, and that it is impossible to represent windings and wiring without drawing the sketches out of proportion, and the same is true for a great many of the cycle diagrams in thermodynamics. Furthermore, I wish to state that, those diagrams in my book which were condemned, as being crude and badly proportioned, have given very satisfactory results in my classes, and have in no case led to any misconceptions.

Whether the expression, "four phase cycle" (when one understands the broader meaning of the word "phase") is a good expression or not, is one of personal opinion; but I do not mean, as the critic assumes, a process by the word "phase"; I mean precisely what I say, viz., *phase*. And there *are* four *phases* to an Otto cycle. However, the statement that "four-cycle is merely an excellent contraction for four-stroke cycle," is ludicrous. The expression "four-cycle" is absolutely misleading to a beginner, since it leads him to expect that there are four cycles taking place in the engine to some *one* other event. Whether "aspirating" and "expulsion" strokes are good expressions or not, the critic may question; but they certainly *do* express precisely what takes place. The critic maintains that I had no excuse for inventing the term commercial efficiency. I agree with him, and am only too sorry that I cannot claim credit for having invented this useful term. Whether the book would be of greater value if compressed into two-thirds the space, is again one of personal opinion; however, let us hope that Prof. Marks' severest strictures will not deter others from writing books, and from inventing useful terms.

There is, however, one criticism that Prof. Marks makes which is of an entirely different nature, viz., "There is no tabulation of the properties of steam, but the old equation for the total heat of steam, which has now been superseded, has been retained. This leads to a notable inconsistency, since the author (p. 176) uses values for the total heat, which are taken from tables based on the newer equations, and consequently do not agree at all with his formula." Had Prof. Marks quoted me, I think his criticism would appear altogether different; for after giving the two empirical equations, I state that the equation for the heat of vaporization is not quite as accurate as that for the total heat, but it is sufficiently precise for most steam calculations, since by means of it the heat of vaporization is found with an error of less than 1% between 100° F. and 400° F. Whether the two values "do not agree at all" depends upon the purposes for which they are used. The value given on p. 176 for the total heat of steam for 80 lb. pressure, as found in Peabody's "Steam Tables," is 1182.0, and the value for the total heat of steam as found by means of the empirical equation for the same pressure is 1177.2, a difference of precisely 0.4%. Now, every engineer knows that in making computations for the thermal efficiency of an engine, based upon experimental data, either of the values here given might be used indifferently, since no engineer, assuredly, would express the thermal efficiency of an engine to more than three significant figures. The following table shows that between 130° F. and 420° F. the total heat of steam, as found by the empirical equation, never differs by more than 0.5% from the values as given in Peabody's "Steam Tables":

Temp., deg. F.	By empirical equation	From Peabody's tables	Diff. %
130	1121.6	1116.7	0.4
160	1130.8	1129.4	0.1
190	1139.9	1141.5	0.1
220	1149.1	1153.0	0.3
250	1158.2	1163.5	0.5
280	1167.4	1173.0	0.5
310	1176.5	1181.4	0.4
340	1185.7	1188.9	0.3
370	1194.8	1195.4	0.1
400	1204.0	1201.0	0.3
420	1210.1	1204.1	0.5

Is Prof. Marks ready to put himself on record, as an engineer and teacher, that he instructs his students that a serious error may be introduced in the final results by using a value for the total heat of steam, which may be in error by 0.5%, despite the fact that every engineer knows that brake power, indicated power, indicated pressure, quality of steam, and water consumption may be in error by as much as 2 or 3%? And if it be acknowledged that no serious error is introduced, then why the criticism? Still, one could not feel too certain that such is not Prof. Marks' method; for we find in the "Steam Tables" by Marks and Davis the following statement: "The data upon which steam tables must be based are well known only to about 400°. It is, however, often convenient to be able to work roughly at much higher temperatures. Table I has, therefore, been extended to the critical point itself, but the values above 400° should not be used with too much confidence (see the discussion of sources in Part III of this book)," and then we find the values given for the total heat of steam from 400° F. to 440° F., which "should not be used with too much confidence," to five significant figures, and from 450° F. on up to 600° F., to four significant figures!

If Prof. Marks realized, at the time when he made his criticism, that the values for the total heat of steam, as found by means of the empirical equation, for the range as indicated in the foregoing table of comparisons, are in error never exceeding 0.5%, and that most tests are made between these limits, then he might read with profit the article

on "Real and Imaginary Accuracy," to be found in the Appendix to Goodman's "Mechanics Applied to Engineering."

F. M. HARTMANN, Professor in Charge of Dept. of Electrical and Mechanical Engineering, Cooper Union.
New York City, Apr. 27, 1912.

Sir—I am sorry that Prof. Hartmann is dissatisfied with my review of his book. There is nothing to be said in reply to the first half of his letter. The latter half, to which apparently he attaches most weight, deals with one point only, namely, the importance of the error in his book resulting from the use of an equation which is inconsistent with certain tabulated values.

By measuring the total heat of steam from the customary starting place, he shows that the error does not exceed ½ of 1%. His method of determining the importance of the error is not, however, a correct one. If he had chosen to measure the total heat from the condition of ice at 32° F., he would have found a still smaller percentage of error. The importance of the error depends upon the use to which the total heats are being put. For instance, to take an extreme example, suppose it is desired to determine the increase in the total heat of dry and saturated steam which is being raised in temperature from 370° to 420° F. An inspection of the table which he includes in his letter shows that according to the empirical equation the increase is 15.3 B.t.u.; according to Peabody's Table 8.7 B.t.u. The equation gives a value which is greater than the tabular value by 76%.

LIONEL S. MARKS.
Cambridge, Mass., May 4, 1912.

Comments on the Review of "The Elements of Structures"

Sir—In your issue of Apr. 18 appeared a review of my book, "The Elements of Structures." It is impossible to conceive how the reviewer could have failed to grasp the relation of this text to other structural engineering texts of the Extension Division of the University of Wisconsin. The reviewer states that "such brief and condensed presentation of topics so large, and needing so much amplification, does not seem to be sufficient to give a proper mastery of the subject." He also says "a young man who has had as much preparation as is presupposed by the author should have something more than this compendium put into his hands." And in another place he states that "the reviewer must believe that the demand should be for something larger and more complete."

The easily read one-half page preface contains the following statements: "It is a prerequisite course to all the regular structural engineering studies offered by the Extension Division of the University of Wisconsin and treats only of the general methods to be followed in design. The methods in detail for the different types of structures are given in the courses which follow." In the body of the book the reader is repeatedly made to realize that the course is only an introductory one and that more extended treatment of the various structures is given in the courses to which this course is preliminary.

In correspondence teaching we have to deal with a class of students who desire to specialize and who are generally at work in that branch of engineering in which they desire instruction. This is not the case in residence work. "The Elements of Structures" which the reviewer seems to consider as a complete structural engineering course, is merely a very simple statement of the bare fundamentals intended to bring all students to a common ground, and to give each student a survey of the field which he could not possibly obtain by taking up an exhaustive treatment of one subject at a time.

The text in question is a framework around which the higher courses are built and serves its purpose of creating interest in, and appreciation of, the regular courses which follow. I am glad the reviewer unintentionally has agreed with me "that it gives the young man a good start in the right direction" — this is exactly what was intended.

If the reviewer actually believes that some of the standard treatises on the theory of framed structures would serve for correspondence instruction, he has no conception of the difficulties which confront the instructor of correspondence students. Even university graduates will shun the ordinary textbook and it is generally more than useless to persist with any instruction based upon such a book. The student, however, wishes to obtain an equivalent in a kind of text which will be simple and direct, without extended mathematical discussions, and which will contain concrete numerical problems rather than the constant use of sign language as found in the ordinary textbook. The average correspondence student studies his lessons under adverse conditions. He is usually ambitious, but there is a limit to the amount of time which he can devote to extended analytical discussions after he has returned home from a hard day's work.

The minor defect to which the reviewer calls attention in Figs. 3a and 3b will cease to exist if the purlins are considered as held in place by purlin hangers.

G. A. HOOL, Assistant Prof. Structural Engineering, Univ. of Wis.
Madison, Wis., Apr. 22, 1912.

[Prof. Fletcher has replied to the above as follows:]

Sir—The reviewer distinctly admitted having had no connection with correspondence schools, and no experience in dealing with students demanding the sort of instruction which such connection would imply. The author now refers to "other structural engineering texts of the Extension Division of the University." As the reviewer has not seen these texts he admits further disqualification for the rôle of critic.

But the reviewer has again reviewed the book and tried to take the attitude of a student; and with all due respect to the author, and with ample acknowledgment of many excellent features, such as clear statement and effective presentation of what there is, the reviewer cannot think that all of the topics are treated with due proportion and sufficient completeness, even for the purpose announced. The chapter on shop drawings has 26 lines of text, two elevations of a column and four isometric views. The chapters on the steel handbook (34 pp.) are very much more full than one would expect in a merely introductory text. The chapter on influence lines, covering only 5½ pages, is hardly appropriate here, and should have been longer if it is to have a place. It properly belongs in the "higher" textbook or books.

ROBERT FLETCHER, Director, Thayer School of Civil Engineering.
Hanover, N. H., May 2, 1912.

REVIEWS

Two Notable Books on Steam Turbines

Reviewed by H. E. LONGWELL*

THERMODYNAMICS OF THE STEAM TURBINE—By C. H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 282; 103 text illustrations. $3, net (12s. 6d., net).

STEAM TURBINE DESIGN—With Especial Reference to the Reaction Type, including Chapters on Condensers and Propeller Design. By John Morrow, M. Sc., D. Eng.; Lecturer in Engineering, Armstrong College, Newcastle-on-Tyne. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 6x9½ in.; pp. 471; 179 text illustrations (with chart in pocket of cover, sold separately at 1s. 6d., net). $4.50, net.

Prof. Peabody has given us a very excellent treatise on the elementary principles of steam-turbine design, with the minimum amount of thermodynamics that is compatible with an intelligent consideration of the action of the steam in its passage through the turbine.

It is in fact the least formidable of the many works dealing with the theory of steam-turbine design, and on this account is all the more commendable. It can be digested without much difficulty by anyone who has a modest acquaint-

*Consulting Engineer, The Westinghouse Machine Co., East Pittsburg, Penn.

ance with thermodynamics, and a reasonably good knowledge of elementary mechanics, algebra, plane geometry and trigonometry, and the graphical resolution of velocities and forces. There are a very few equations involving the integral and differential calculus, but these are so unusually rare that the student might safely accept the results, without worrying about the proof; just as engineers are content to accept 3.1415 + as the value of π, although nearly all of them have forgotten how to prove it.

Comparatively little consideration is given to actual constructive details, except for illustrative purposes; this is an innovation that might with advantage be carried a little further, as there is no logical reason for complicating a work of this sort by incorporating matter that properly comes within the province of general machine design.

All computations are made by the aid of the author's "Steam and Entropy Tables," which has proven a most convenient and useful tool for steam-turbine designers, and which has replaced the partial tables that many of them had laboriously calculated for themselves.

This first edition is unfortunately marred by a considerable number of typographical errors and omissions, evidencing inexcusable carelessness in the correction and revision of the proof sheets. Typographical errors in mathematical work are peculiarly disastrous, as the average reader has an unduly modest opinion of his own mathematical knowledge, and an exaggerated confidence in the infallability of printed books, especially those of authors of acknowledged reputation and ability. As a consequence, when he encounters a mathematical demonstration which he is unable to follow, he is apt to become discouraged, and to conclude that the matter is beyond his capabilities.

Chapter I is a condensation of the introduction to the author's "Steam and Entropy Tables," and as such constant reference must be made to that publication, there does not seem to be much reason for duplicating this matter.

Chapters II and III treat the general subjects of nozzle design, jets and vanes in a plain, straightforward manner.

Chapters IV, V, VII and VIII are devoted to a study of the impulse turbine. Beginning with the simple single-stage, single-wheel turbine, the reader is led by easy and logical steps up to the most complex forms of this general type, in which both the pressure and velocity of the steam are compounded; and a number of hypothetical designs are calculated, which illustrate the practical application of the formulas that are developed.

Chapter IV contains an exceedingly simple but nevertheless wholly sufficient mathematical analysis of rotating disks of uniform strength. With the single exception of the determination of the maximum value of the expression for the work of impulse on p. 31, this analysis of the rotating disk is the only section of the book involving the calculus. In his treatment of geometrically similar wheels, on pp. 58-9, the author is less fortunate. The reasoning is faulty and the result sought to be proven is really assumed.

In the discussion of pressure compounded turbines, considerable attention is devoted to methods of dividing the total heat drop equally among the several stages. Especial prominence is given to an original and interesting method devised by the author. This equal division of the heat drop is, however, more a matter of theoretical than of practical interest, as the experienced designer will in most cases have good reasons for dividing the heat drop unequally. The usefulness of the book would be enhanced by the addition of a few calculations to show how little the theoretical over-all efficiency is affected by a considerable inequality in the division of the total heat drop.

In Chapter VIII the reaction or "Parsons" turbine is taken up, but the theoretical treatment is rather too brief to be satisfactory. The author is of the opinion that the action of the steam in this type of turbine is so complex, and its real nature so uncertain, that a minute theoretical study is hardly worth while. He adds that "There is further discouragement from the usual theoretical treatment, because it is stated that the Parsons company do not use the results of such a discussion in design, but rather depend on certain empirical equations, which, though crude, are so controlled by comparison with tests as to give reliable results with little labor."

This practice is not peculiar to the Parsons company nor to the commercial designing of reaction turbines. Designers of nearly every kind of machinery make very free use of empirical formulas, based on results that have been actually obtained in practice. The principal value of theoretical treatment in machine design lies in the fact that it enables us to examine our present work critically, and it constitutes a reliable indication as to the general direction in which it is profitable to pursue further experimental work. When one is satisfied with his experimental design, empirical formulas are in general all-sufficient for the translation of this experimental design into the several modifications that are needed to meet the various requirements of commercial service. There are doubtless many designers of reaction turbines who would take issue with the author on the general proposition that this type of turbine is not as amenable to theoretical treatment as is the impulse type. On p. 203 it is estimated that the axial thrust is trifling. The author probably means that there is no appreciable axial thrust due to the *velocity or flow of the* [illegible]*am.* Without qualification, this state[illegible]t is rather startling to one who is a[illegible] of the very considerable axial thrust [illegible] to the *pressure of the steam,* which [illegible]t be balanced by dummy pistons or oth[illegible]ise.

A calculation of the design of an [illegible]500-b.hp. reaction turbine is included [illegible] this chapter.

Chapter IX, which is devoted to a brief description of several types of governors, valve gear, gland packings, and condensers, is comparatively unimportant, as most of the matter is purely descriptive, and in general, is to be found in trade catalogs.

Chapter X deals in a brief but interesting manner with a number of special points, such as the distinction between efficiency and economy; the advantages of superheat and high vacuum; abstracting partly expanded steam from the turbine for heating purposes; utilizing exhaust from high-pressure auxiliaries in the low-pressure section of the main turbine, etc. Passing reference is also made to low-pressure turbines, heat accumulators, mixed pressure, compound and combination turbines.

The concluding chapter is made up of short notes on propellers, marine steam turbines and their arrangement in ships, geared and electric drives for marine propulsion, together with data abstracted from the *Journal* of the American Society of Naval Engineers, regarding the turbines and performances of four U. S. torpedo-boat destroyers—"Sterett," "Perkins," "Roe" and "Terry."

At the end of the book there is a Mollier Total Heat-Entropy diagram drawn to a comfortably large scale, which will doubtless be appreciated by those who like that sort of thing. However, when one has familiarized himself with the use of the author's "Steam and Entropy Tables," he ought not to have much of a predilection for heat diagrams.

The most annoying of the many typographical errors already mentioned are as follows:

In the equation for velocity on p. 17, the number under the second radical should be 19.8 instead of 66.6. In the left-hand members of equations (7) and (7a), on p. 18, the factor A—the reciprocal of the mechanical equivalent of heat—has been omitted, and on p. 22 the value of A is inadvertently given as 778 instead of $\frac{1}{778}$.

In the nozzle-design problem, the final arithmetical computations on p. 26 are just sufficiently inexact to raise in the mind of the reader a suspicion that perhaps none of the illustrative examples are worked out with a creditable degree of accuracy. The first mathematical expression on page 111, and the denominator of the fraction on p. 114, both lack the inclosing brackets and the exponent [illegible]

The book contains several errors that are amusing rather than serious. For example, engineers who are conversant with the hydraulic heads effectively negotiated in the West by water wheels of the impulse type will hardly accept the statement on p. 27, that a hydraulic head so great as 348 ft. "is seldom if ever applied to a single turbine and would be considered inconvenient." On p. 117 we are told that the actual output of a 5000-kw. turbine at 0.85 power factor is about 5890 kw., which puts a new interpretation on the term "power factor."

An equally surprising bit of information is to be found at the bottom of p. 228 i.e., that practical isochronism is a characteristic of all properly designed relay governing systems. And finally, on p. 258, by a thoughtless assumption the author proves that it is cheaper to waste the exhaust from a noncondensing auxiliary than to utilize it in the low-pressure stages of the main turbine.

To summarize briefly: The work is admirably conceived and carelessly executed. It is a textbook and not a draftsman's *vade mecum*. A student who has mastered the direct and simple theoretical principles set forth therein will have acquired a grounding that should qualify him for beginning the study of steam-turbine design and construction from the practical standpoint, which he can prosecute only by personal contact with the actual work itself.

It might be added that a book on the underlying principles of steam-turbine design should be criticized in a charitable spirit, as in the present state of the art the preparation of such a work is no mean task. The successful, practical designer will not write books, and he is not prone to assist others to write them. Consequently, we are obliged to look to the academic writer, who must evolve the material largely from his own inner consciousness, and it would be strange indeed if this material did not require considerable re-shaping and polishing to render it flawless.

The author of "Steam Turbine Design" is a lecturer in engineering at Armstrong College, Newcastle-on-Tyne, the home of the Parsons turbine, which perhaps accounts for the fact that the work deals principally—indeed almost exclusively—with this type of turbine. The fact that the Tyne is one of the largest shipbuilding centers in the world possibly explains why the book gives more prominence to marine-turbine design than will be interesting or attractive to the average American reader.

The marine turbine, divided as it usually is into two or three independent cylinders, with backing and cruising elements, is a complicated problem at best, and should not be approached by the student until he is fairly well grounded in the elementary principles and has learned to apply them to the simpler types of turbine. The author, however, attacks the problem of the marine turbine at the very outset, and gives comparatively little attention to the commoner types used on land. In this respect his treatment of the subject is unfortunate, and his book is better suited to the needs of an advanced student who desires to specialize in marine work than it is to the needs of one who is taking up the study of steam-turbine design for the first time.

Nearly one-quarter of the book is taken up with sections dealing with the design of screw propellers, heat accumulators, reduction gearing and condensers, so that it partakes somewhat of the nature of a "compendium of engineering."

Chapter I gives a general description of the reaction turbine, with a number of excellent sectional cuts, showing the distinguishing features of the characteristic designs of several different manufacturers. Chapter II is sufficiently described by its caption, Fundamental Principles.

Then follow the inevitable chapters on entropy-temperature diagrams. These we are obliged to accept with nearly every book that treats of any type of heat engine, notwithstanding the fact that the same matter appears in most treatises on thermodynamics, and that so many books have been published which deal exclusively with the subject.

In the thermodynamic design the author uses the temperature-entropy method. With the meager data given in the earlier steam tables, this method had much to commend it. Now that we have elaborate steam and entropy tables, like those of Peabody, and Marks and Davis, the diagram method appears unnecessarily laborious and indirect, and many will be inclined to regard it as being more picturesque than practical.

Chapter V takes up the general outlines of design, and gives, among others, a number of formulas and rules for which the derivation is not shown. Chapter VI, Theorems on Reaction Turbines, is largely mathematical. Chapter VII is devoted to the calculations for several examples of marine turbines.

Next comes a chapter on Heat Diagrams, illustrating all of the conceivable ways in which the several properties of steam may be plotted. This is followed by a fairly comprehensive study of the heat accumulator, or regenerator, with brief references to exhaust and mixed pressure turbines.

The four chapters following treat of the specific design of turbine, "scantlings" and details. By "scantlings" the author means the cylinder, rotor and flanges. The term is probably borrowed from the nomenclature of naval architecture, and its use in this connection is decidedly uncommon. This subject is treated from the standpoint of pure machine design. The illustrations are doubtless made from drawings of actual structures, and these drawings, together with the formulas presented, will be useful to the draftsman engaged in working up the mechanical details of any particular design.

Chapter XV is a general consideration of the subject of marine turbines with a few illustrative examples. A chapter on Turbine Propeller Design follows, concerning which it is not safe to say anything, for the reason that if there is any one subject on which all the doctors disagree, it is propeller design.

Nineteen pages are devoted to reduction gearing for marine turbines, with especial reference to the theory of tooth design. The theory and practice of condenser design occupy the next two chapters, 44 pages in all.

In the two concluding chapters the author gets back to his subject, and briefly discusses orifices and nozzles, and impulse turbines. There is an appendix treating of the geometry of the screw propeller. A pocket on the inside of the back cover contains a new addition to the diagram family, on which the properties of steam are plotted with volume and total heat taken as the rectangular coordinates.

The book evidences great care and labor in its preparation, is well printed, and for a first edition is remarkably free from errors typographical and otherwise. It covers a wider range of subjects than is desirable in a single volume, and it is doubtful if the matter is arranged in the most logical order. On the whole it is an interesting work, but, as intimated earlier in this review, its real value is confined almost wholly within the limits of the special field of marine-turbine engineering.

ELECTRIC IGNITION FOR COMBUSTION MOTORS — By Forrest R. Jones, M. E.; M. Am. Soc. M. E. and Soc. Prom. Eng. Ed.; formerly Professor of Mechanic Arts, University of Tennessee, etc. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth: 5¾x9¼ in.; pp. xii + 438; 294 text figures. $4, net (17s., net).

This is probably as complete a work on electric ignition for combustion motors as has ever been written. The range of the subject matter is from the smallest ignition apparatus used on motor cycles to that used on the largest gas engines. The book appears to be quite up to date, covering adequately the more important of the numerous innovations in electric ignition developed within the past few years in connection with automobile engines.

The book is written in such a way as to be understandable by readers having no previous acquaintance with electricity and electrical devices. An introductory chapter covers the elements of electricity involved in the ordinary electric ignition

systems. Chapters II to XV deal with the low-tension ignition systems, and Chapters XVI to XX with high-tension systems. The remaining seven chapters take up such subjects as the care and adjustment of ignition systems, and the care, charging and testing of storage batteries.

The book is profusely illustrated with halftones showing the apparatus described, and with line drawings showing the construction and arrangement of the various ignition systems and their details.

Economy in Industry

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES—By Harrington Emerson. Third edition, revised and enlarged. New York: The Engineering Magazine. Cloth; 5x7½ in.; pp. 254; illustrated. $2, net.

THE TWELVE PRINCIPLES OF EFFICIENCY—By Harrington Emerson. New York: The Engineering Magazine. Cloth; 5x7½ in.; pp. 423. $2, net.

Mr. Emerson has long preached the need and chance for "efficiency" as a feature of modern shop management—something which a few have hailed as a royal road to cheaper production and which others have suspiciously regarded as some sort of a magic process of making money not easily comprehended. Some of the fog that hangs over nearly all these discussions would clear if we would substitute simpler terms for the rather imposing nomenclature that has sprung up. We could not then take refuge in indefinite and broadly inclusive expressions; and that would be well, for all that has been agitated can be reduced to the simplest and most familiar ideas.

For instance, in many places in Mr. Emerson's book, "economy" in place of "efficiency" would bring the intended idea home closer to most people. We would all think more clearly if we stuck to "efficiency" as a ratio of an output to an input—leaving for "economy" such ideas as the ratio of one performance to a higher attainment, or the ratio of the difference betwen the two and one of them. The difference between an actual and an attainable industrial operation is obviously a preventable waste of material and labor. Its comparative size is a measure of *economy*, something everyone can comprehend. These are old distinctions in economics as well as engineering (as may be gathered for example from the general treatises of the late Dr. Francis Walker, former head of the Massachusetts Institute of Technology, and from Prof. Alfred Marshall's discussions of industrial economics) though never consistently adhered to by economists and frequently not by engineers.

Similar mild criticism applies to the title "Twelve Principles" and to some of the "principles" individually—although the reader should be reminded here that Mr. Emerson's expostulations against waste should be productive of great good by reminding us of miscellaneous but specific ways in which we have failed as manufacturers. If we had read the text of "Twelve Principles" before the title we would have selected something like "Roads to Economy in Industry" rather than "Twelve Principles of Efficiency," for the book is not a homogeneous code of axiomatic propositions, generalizations of experience, or rules of action, applicable to all human effort. It is rather a series of verbal volleys against definite wastes, and as such is welcome.

The first of these two volumes at hand, now appearing in a revised edition, was the author's earlier broadside on flagrant waste and was probably intended to be only very general. Therefore, there should be little wonder that it leaves only rather indefinite impressions of ways and means of economy—except, of course, for the incessant repetition that "staff must supplement line." This expression is used to describe what seems to be an extension of the economist's "division of labor," by which the familiar (military) type of manufacturing organization gets the continued benefit of expert study and advice on the best technique of every act. Mr. Emerson even goes so far as to call it the "efficiency type" of organization.

The second book supplies the specific directions for effort, which we presume were sought of the author after he had presented the earlier volume. A study of all that Mr. Emerson says leads to the feeling that we have here unfolded the workings of a single economic law—an industrial exhibition which Prof. Marshall seemingly prophesied in the later editions of his "Economics of Industry." He showed the existence of two opposing tendencies in industry: (1) the diminishing extra return of raw material derived from nature by extra applied capital and labor, and (2) the increasing result from productive efforts with increased volume of work, further organization, etc. We may regard the industrial betterment secured by Mr. Emerson and his contemporaries as an evidence of this law of increasing returns.

Economists, not often being industrial specialists, have stopped short with the recording of this tendency; Mr. Emerson gives a broad classification of a program which his observation and experience teaches has increased efficiency of human effort and economy in use of raw materials. It is true that men of rare ability have intuitively embodied in their work many of the schemes which Mr. Emerson expounds, thereby preventing waste of material and making their employees' efforts more effectual. Such experiences necessarily must have occurred before anyone could generalize them into economic or industrial principles. But as organizations have multiplied and grown there have been too few of these naturally masterful minds to go around, and the limitations of human effort have been too great to secure a corresponding development of technic in all operations. It has remained for men like Mr. Emerson to set down for the less discerning of us some reasons why certain organizations have achieved success and how we may hope to apply their methods to large-scale production. What he tells us in the books before us we could perhaps glean from study elsewhere, but in fragmentary and unrelated forms. When Adam Smith presented his great treatise expounding among other things the hope of profits as a motive of business, the need of freedom of individual effort, and the justice of profit for both parties to a transaction, the essentials of such doctrines might have been sifted from many earlier writings. His contribution was no less for that, however, and similarly our debt to Mr. Emerson and his contemporaries is no less because we have failed to find the obvious which they disclose.

Mr. Emerson's list of "principles" is as follows: (1) Clearly defined ideals, (2) supernal common sense, (3) competent counsel, (4) discipline, (5) a square deal, (6) records, (7) dispatching, (8) standards and schedules, (9) standardized conditions, (10) standardized operations, (11) written standard practice instruction, (12) efficiency reward. These words or phrases he places at the head of each chapter as "principles." He follows them by assertions and illustrations of the benefit of following the rule (unstated but easily inferred and involving the particular words or phrase in question). For instance, the chapter on "Principle One" pictures the evident aims of men in various constructive organizations and the results secured, from which we learn in a rather vague way that we will do better to put such aims as service, low cost, small profits on big outputs, contented and effective workers, etc., above aggrandizement, vast riches, power, adulation, etc., and that this has a marked effect in increasing the effectiveness of labor.

Mr. Emerson gives 12 "principles," but we think many readers will discover a fewer number of independent ideas; for instance we might regroup them as follows: (1) "competent counsel"—use of expert advice—"union of staff to line," (2) good practical ideals, like high quality and larger output of products, (3) wise foresight or "supernal common sense," (4) discipline—penalties for broken rules, subjection to orderly schemes, etc., (5) a fair deal—giving to each man his chance, finding his proper sphere, paying a wage fairly earned, (6) records of materials used, of actual time spent, of preëstimated attainment, of process instruction, (7) dispatching and schedules, an attempt to adhere to a prearranged plan of progression, (8) optimum conditions for economy and effectiveness, (9) a labor stimulus for reasonably greater effort.

Each reader's desire to variously recombine and rearrange the elements only

indicates a mental stimulus in the book; it cannot be construed as an arraignment of its utility.

Abridged Graphic Statics

Reviewed by HENRY S. JACOBY*

A SHORT COURSE IN GRAPHIC STATICS—For Students in Mechanical Engineering. By William Ledyard Cathcart, M. Am. Soc. Naval Engrs.; M. Am. Soc. M. E., and J. Irvin Chaffee, A. M., Professor of Mathematics, Webb's Academy of Naval Architecture and Marine Engineering; M. Soc. Naval Archts. & Marine Engrs. New York: D. Van Nostrand Co. Cloth; 5x7¾ in.; pp. 183; 58 text figures. $1.50, net.

This book is practically an abridgment of a work of 312 pages octavo by the same authors, entitled "Elements of Graphic Statics," which was reviewed in Engineering Literature for Mar. 16, 1911. The solution of examples, taken mostly from mechanical engineering practice, occupies a larger proportion of space, while the examples are not always the same as in the larger book. The space devoted to the different chapters is as follows: Force and equilibrium polygons, 22 pages; stress diagrams for trusses, 18 pages; shears and moments due to stationary loads, 32 pages; shears and moments due to live loads, 37 pages; center of gravity and moment of inertia, 24 pages; and friction, 41 pages. A series of 35 problems for solution and an index complete the volume.

The text is clear and concise and seems to be well adapted for a class if the teacher desires to have the contents limited to the requirements of a short course of study. In a new edition the term complanar ought to be replaced by the English word coplanar. Naturally this would be regarded as a typographical error were it not for the fact that the same term is employed in the larger volume.

PRACTICAL SEWERAGE AND SEWAGE DISPOSAL—By H. C. H. Shenton, F. S. E., M. I. Mun. E., M. R. San I. London: S. Edgecumbe Rogers (27a, Farringdon St.). Cloth; 5x7½ in.; pp. 148; illustrated. 3s. 6d., net; American price, $1.40, net.

A relatively brief review of current British sewerage and sewage-disposal practice is here presented by an engineer of experience who is at the same time familiar with what his countrymen have written on the subject. The aim of the author was to make his book "practical." To that end he has omitted mathematical and theoretical discussions and has also left out descriptions of methods and apparatus which might have been included in a larger book for the sake of either historical interest or for completeness. In place of "elaborate tables and methods of calculation" the author gives "ordinary minimum gradients for sewers of circular or elliptical section" because "in nine cases out of ten all that the engineer wants to know is the flattest gradient he can use and the velocity of flow." His object being to give definite advice to those in charge of actual work he omits "descriptions of unsatisfactory methods."

In general content and order of arrangement the book is consistent with its title and stated aim. It deals as fully as so small a volume could be expected to deal with the various details of sewerage design, gives some pointers on sewerage maintenance, and takes up the various current British methods of sewage treatment by means of tanks, contact beds, percolating filters and land, the latter being made to include intermittent filtration and broad irrigation.

The book contains less on construction and perhaps less on operation than might be expected. On sewage treatment any one outside England might think that too large a portion of the book is devoted to the conclusions of the Royal Commission on Sewage Disposal and the author's dissent therefrom, but in a "practical" British book on sewage disposal the Commission may properly bulk large and since it has not yet made its final report, it is well to have British engineers express themselves freely regarding the preliminary conclusions of the Commission.

It is interesting to note that Mr. Shenton places more confidence in revolving than in fixed sewage sprinklers, which, while contrary to American ideas, is in line with British practice. The author also expresses a strong preference for hypochlorites produced by electrolytic action at sewage works over the commercial chemical product, which also seems to be at variance with American experience—though the latter is confined almost wholly to water disinfection, and the British have done little but experiment with hypochlorites for either water or sewage treatment.

Altogether, Mr. Shenton's little book (which by the use of compact text is not so small as its stated size suggests) promises to be a useful addition to the books on the subject—which is saying a good deal in view of the number already in existence.

LABORATORY MANUAL FOR THE USE OF STUDENTS IN TESTING MATERIALS OF CONSTRUCTION—By L. A. Waterbury, C. E., Professor of Civil Engineering, University of Arizona; M. Am. Soc. Testing Materials; Assoc. M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x7½ in.; pp. 270; 68 text figures. $1.50, net. (6/6, net.)

This manual is intended to be used by students in testing-materials laboratories in technical colleges to assist them in making their tests and in preparing their reports. It contains first, chapters on general instructions and descriptions of the various types of testing apparatus and is followed by a series of problems on the tests of cement, concrete, iron and steel, brick, sand, gravel and stone, asphalt and wood. There are eight appendices giving the various standard specifications adopted by societies on cement, stone, concrete, steel and paving brick. Each problem is divided into separate paragraphs headed respectively, Object; Apparatus Required; Materials Required; Methods of Operation and Reports, so that the students may follow the testing operations from beginning to end. The preface states that the present volume contains nearly all of the matter included in the author's former Cement Laboratory Manual, which was reviewed in ENGINEERING NEWS, Dec. 17, 1908, p. 694.

STEAM POWER PLANTS—Their Design and Construction. By Henry C. Meyer, Jr., M. E., Consulting and Mechanical Engineer. Third edition, entirely rewritten and enlarged. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 219; 21 plates and 67 text illustrations; 33 tables. $2, net.*

The author's intention of preparing a treatise on the elements of steam-power plant design especially for mill and factory engineers whose knowledge of machinery of such a character is not particularly intimate and whose circumstances do not permit securing the advice of a competent consulting engineer, seems to have met with appreciation—if the appearance of this, the third edition, is an indication. The first edition was favorably reviewed in ENGINEERING NEWS, Mar. 19, 1903, and the one or two minor statements then criticized seem to have been changed here. Comparison with the original work shows that there has been a fairly general revision and, more important, an addition of matter on steam turbines, steam piping, condensers and chimneys. The book may now be considered to show conservative practice reasonably up to date.

"Steam Tables for Condenser Work" is the title of a booklet recently published by the Wheeler Condenser & Engineering Co., of Carteret, N. J. Three tables are given, the most notable of which is one giving the properties of saturated steam at pressures varying by $\frac{1}{10}$-in. of mercury from 29.8-in. vacuum to atmospheric pressure. The second table gives the properties of saturated steam from 32° to 212° F. for each degree. Table III gives the properties of saturated steam for gage pressures of from 0- to 200-lb. gage.

The preface states that these tables are based on the properties of saturated steam given in the latest tables of Marks and Davis and were especially calculated for this book by Professor Marks. Following the tables, there is a discussion of the use of mercury columns and barometers and also tables for the correction of vacuum gage and barometer readings. The booklet is not offered for sale, but will be sent to any responsible mechanical engineer upon application.

*Professor of Bridge Engineering, College of Civil Engineering, Cornell University, Ithaca, N. Y.

The Art of Refrigeration

Reviewed by REGINALD P. BOLTON*

ELEMENTARY MECHANICAL REFRIGERATION—A Simple and Non-Technical Treatise. By Fred E. Matthews, B. S., M. E., E. E.; M. Am. Soc. M. E., M. Am. Soc. Refrig. Engrs. New York and London: McGraw-Hill Book Co Cloth; 6¼x9½ in.; pp. 172; 43 text figures; 24 tables. $2, net.

It is always of interest to those concerned in one of the many branches of engineering to receive a clear re-statement of the ascertained conditions of their own art, even if such a statement be largely a compilation of fundamental facts. Since the ranks of the profession are continually receiving accessions of young men, such a presentation of mechanical refrigeration is welcome at this time, especially as considerable strides have been made in this branch of engineering in recent years, and the practice of artificial refrigeration is attracting many young men.

Therefore, even though Mr. Matthews' book aims at no deeper purpose than the presentation, in plain terms and simple sequence, of the principles of refrigeration, its author deserves credit for a careful and consecutive method of presentation, and for originality in illustrative comparisons.

The reader, who is addressed by the author as "the busy man at the desk, drawing board, and throttle," should find this work a helpful basis for comprehension of the fundamental features of refrigeration, and therefore an incentive to a wider and deeper study of this important subject. To such men, simple analogies and illustrations are useful in aiding the mind to grasp the elementary principles involved, and equally so are the comparative diagrams of combinations which form heating and refrigerating systems. The author approaches the whole subject from the point of view of the more widely known and more readily understood art of heating, and makes effective use of "the striking similarities between a steam-heating and a refrigerating system."

While a book of this nature is to be commended for its restriction to a complete presentation of one feature of a subject rather than a discursive description of all forms of development, yet it is rather to be regretted that the author has confined his work exclusively to the use of ammonia and has not opened to the reader the door of the modern and increasing usage of carbon dioxide as the refrigerating medium. Nor has he given more than a passing reference to the dense-air process. These omissions leave the student rather in the dark as to whether or not, after having absorbed the information contained in the book and hearing of other media in use for instance, he has fully grasped the whole aspect of the subject as comprised in the title.

Some points discussed by the author are of special interest and might have been discussed at greater length, especially such a subject as the exchange of temperatures through the opening of cold-storage doors and the matter of moisture precipitation, both of which would deserve further study and observation by refrigerating engineers. Moreover, in these days of electrical development, engineers need information on the mechanical effects and economic results of the use of electricity as the motive power of refrigerating systems.

In spite of these points, the book will be welcomed by refrigerating engineers as a useful record and clear explanation of the elementary features of the art of mechanical refrigeration.

*President, the R. P. Bolton Co., Consulting Engineers, 55 Liberty St., New York City.

WHO'S WHO IN SCIENCE (International), 1912 — Edited by H. H. Stephenson. New York: The Macmillan Co. Cloth; 5½x9 in.; pp. 335. $2, net.

A tabulation of the principal universities of the world and a classified index of names according to the branch of science in which the individuals are interested and their geographical location are the chief features of this biographical directory. As might be expected under the circumstances the inference gained from a cursory examination of this book is that a very large part of the world's great scientists are of English origin. Of course, any such compilation is arbitrary and the omission of many names one would naturally expect to find in such a directory is inevitable, as the compiler states in his preface. The biographies of 99 American engineers are included. All the biographical notes are very brief and give only the education and principal work of the individual, generally in less than 150 words.

HIGHWAY BRIDGES AND CULVERTS —By Charles E. Hoyt, C. E.; Superintendent of Construction, in Charge of Bridge Engineering, Office of Public Roads, and William H. Burr, C. E., Professor of Civil Engineering, Columbia University; Consulting Engineer, Office of Public Roads. Bulletin No. 43—Office of Public Roads; U. S. Dept. Agriculture; Logan Waller Page, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 21; 14 plates and 3 text figures.

This Bulletin No. 43 is a revision of the old Bulletin No. 39, which contained the offer of free bridge engineering criticized at the time in the editorial columns of ENGINEERING NEWS. The revised bulletin is the same as the earlier one except that the paragraph offering the assistance of the Office of Public Roads has been modified so that the Office now offers only to send an engineer when practicable to confer with local officials upon their request concerning highway, bridge and culvert work and to make inspections, recommend types of construction and give similar information, whereas the old bulletin specifically stated that the office would make inspections, test foundations for bridges and culverts, recommend types of construction, give "such other information and assistance as may be practical in the individual case, such as making location surveys and preparing preliminary plans, forms of contracts, specifications and estimates." A blank form, offering the services of engineers and inspectors, has been omitted from the revised bulletin.

STANDARD FORMS OF FIELD NOTES FOR CIVIL ENGINEERS—By Chas. C. Anthony, C. E., Instructor in Engineering Mathematics, Union College. New York and London: McGraw-Hill Book Co. Cloth; 4¾x7 in.; pp. 55; 17 plates. $1, net.

The use of surveying instruments is so easily understood and quickly acquired by the average technical student that sufficient time is seldom given him to acquire the more difficult art of keeping neat and legible field notes. The man who learns surveying in the school of experience, on the other hand, uses the notes taken by his predecessors often enough to learn that the keeping of clear and complete notes is not the least important part of the science of surveying.

Although the title of the book before us is a rather ambitious one for its contents, it does contain some essential directions and enough samples of good field notes to be of real use in helping the novice in surveying to keep respectable notes.

The book contains 17 double-page plates which represent typical field notes on railway, topographical and hydrographical surveys and level, stadia and cross-section notes. The text is mainly explanatory of the surveys which the notes record, and contains a number of hints as to survey methods as well as on note taking; it might well be used as an instruction book in surveying exercises. It is not so complete as might be wished for, and many things which the author chooses to call standard might be questioned, as for example Plate E, which shows a sample page of level notes with the stationing from bottom to top of page. However, these do not seriously affect the purpose of the book, which is to impress upon young surveyors the necessity and means of acquiring the ability to take neat and legible notes.

FACTORY MUTUAL INSURANCE—The Achievements of 75 years. Compiled to observe the 50th anniversary of the Arkwright Mutual Fire Insurance Co., Boston, Mass. Cloth; 6¼x9½ in.; pp. 123; illustrated. Privately printed.

The history of the growth of the mutual factory insurance associations of New England forms an interesting part of a publication designed to commemorate the fiftieth anniversary of the Arkwright Mutual Fire Insurance Co., of Boston, Mass. Starting from the idea of Zachariah Allen, owner of a woolen mill in Allendale, R. I., in 1835, the business of the various mutual companies has grown from nothing

to $2,200,000,000 of insurance in the United States and Canada in 1910. The major part of the book is a history of the Arkwright company, and a description of its organization. Much information of interest to all students of fire prevention and the progress which has been made in this branch of engineering during the last half century will be found in its pages. The book was compiled by Edward V. French, Vice-President and Engineer of the Arkwright company.

Carpenter's "Experimental Engineering" Rewritten

EXPERIMENTAL ENGINEERING AND MANUAL FOR TESTING—For Engineers and for Students in Engineering Laboratories. By Rolla C. Carpenter, M. S., C. E., M. M. E., and Herman Diederichs, M. E., Professors of Experimental Engineering in Cornell University. Seventh edition, rewritten and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 1132; 636 text figures. $6, net.

One would naturally expect that any book which had run through six editions and been subjected to changes and additions designed to include the developments of successive years might finally come to lack coherence in scope and treatment. It would be evident, to one who knew the limitations imposed by the commercial side of book publishing, that complete rewriting and resetting of the text for each reprinting would be out of the question and that, in making the various edition changes, it could hardly be possible to foresee and eliminate all annoying contradictions and errors.

The criticisms which have been made against the latest previous edition of this book, printed in 1906, in a large measure can be thus explained; but the explanations make no less desirable a complete rewriting rather than further superficial revision.

Commendation is due to Prof. Carpenter for turning over the rewriting of his book to another person, who would more readily see faults of omission and commission than would the original author, after having gone over the volume so many times.

While our older readers may recall that "Experimental Engineering and Manual for Testing" was a development of Prof. Carpenter's "Notes on Mechanical Laboratory Practice" (1891), yet the book now is commonly known as "Experimental Engineering," and this is apt to give an impression to the unadvised reader that it covers all kinds of engineering laboratory work. It is well to note here, therefore, that the authors have confined their efforts to such work as a mechanical engineer is most called upon to perform—which largely has to do with primary-power apparatus, but involves to a lesser extent the materials of construction. Electrical apparatus, tests of road materials, etc., have been completely disregarded.

In connection with the appearance of this seventh edition under the broad title it is interesting to recall that the second edition of a somewhat similar British work, W. W. F. Pullen's "Experimental Engineering" (1911) has been given the title "Testing of Engines, Boilers and Auxiliary Machinery" as expressing "more explicitly the scope and aim of the subject matter."

In spite of much condensation in the revision of this new volume there are nearly 300 pages more than in the sixth edition, but this has been compensated for by using a thinner paper.

The earlier omission of the American Society of Mechanical Engineers' codes for testing steam engines, pumping engines and locomotives has been made good. In reprinting the various codes of testing methods throughout the book, the repetition of parts already quoted in previous paragraphs is avoided wherever possible and such omissions are marked by a reference to pages already passed. Additional comment on codes is given in footnotes.

The codes or rules for testing gas engines and gas producers, which have been formulated by the American Society of Mechanical Engineers, the British Institution of Civil Engineers and the Verein Deutscher Ingenieure have not been considered sufficiently detailed to be a guide for students. These topics have been taken up in this book at somewhat greater length, although the codes are quoted directly where that is sufficient.

Blank forms are given for all the different tests where fixed logs facilitate the recording of readings and calculations.

There seems at first to be a meager presentation of steam-turbine testing, but a few moments' consideration shows that all that is needed has been given, since such work is comparatively simple and can be amply covered by a few paragraphs in addition to references back to engine- and boiler-testing methods. Several pages, however, are needed for showing the correction of turbine-test results to guarantee conditions, for the separation of losses, etc.

The author's earlier endorsement of calorimeter pyrometers has been made much more conservative and is now above criticism. Electrical pyrometers have been given greater recognition and an adequate presentation.

CO gas is also recognized in this last edition as a very important factor in flue-gas analysis and actual boiler operation, because of the large fuel loss represented by a small escape of unburned CO. Much more attention is also paid to the heat-balance computations from a boiler test to definitely allocate the various losses.

Under the topic "interpretation of steam-engine indicator diagrams," the effect of faulty valve setting is a valuable feature now introduced. This was particularly needed, since in many plants valve setting is all the indicator is used for. The great space formerly given to the excellent but painful Hirn's analysis (calorimetric method of engine testing) has been cut down to one-third the space, which brings it into better proportion with the other portions of the text.

The same wise rearrangement has been made of the old opening chapter on least squares, which was possibly given more prominence as a method of determining probable errors in a series of observations than actual practice would recommend. That section now is only part of a much more comprehensive introductory chapter and ranks with such preliminary discussions as "objects of engineering experiments," "rejection of doubtful observations," "when to neglect errors," "graphical representation," etc.

In an earlier review of this book (ENG. NEWS, Nov. 15, 1906, p. 520) the following remark was made by an eminent mechanical engineer:

> It is to be hoped that the author will reedit the book throughout, correct the errors, omit such descriptive matter and verbiage as is unnecessary, add to subjects which are incomplete and thus produce a model—not only as regards superficial pretension, but also as regards real worth.

All that was then asked for now seems to have been done.

ENGINEERING DIRECTORY — Edition of 1912. Chicago, Ill.: The Crawford Publishing Co. (537 So. Dearborn St.) Stiff leather; 4x6¾ in.; pp. 1496. $5, net.

Although called an engineering directory, this is more properly a manufacturers' directory. Besides the names and addresses of manufacturing concerns, the book contains also the names of jobbers, dealers, manufacturers' agents, railway purchasing agents, architects, electric-lighting and power companies, gas and water-works companies and trade associations. About 6000 manufacturers and 4000 varieties of engineering manufactures are listed in this handy volume.

THE ESSENTIALS OF LETTERING—A Manual for Students and Designers. By Thomas E. French and Robert Melklejohn, The Ohio State University. Third edition, revised and enlarged. New York and London: McGraw-Hill Book Co. Cloth; 9x6¼ in.; pp. 94; 120 text illustrations. $1, net.

This is a third edition of a book reviewed in our columns on Apr. 14, 1910. It has been somewhat enlarged and the additional matter will prove of value to the artistic designer. The book as a whole is especially adapted to architectural and art drawings, although the essentials of good freehand lettering are clearly and concisely given. As there are often occasions in work of the civil engineer when it is not only desirable but almost essential to have really artistic drawings, many civil engineers will find pleasure and profit in studying the contents of this book.

Notes on Some Recent Electrical Books

Reviewed by HENRY H. NORRIS*

STORAGE BATTERIES—The Chemistry and Physics of the Lead Accumulator. By Harry W. Morse, Ph. D., Assistant Professor of Physics in Harvard University. New York: The Macmillan Co. Cloth; 4¾x7½ in.; pp. 266; 106 text figures. $1.50, net.

DIE KRANKHEITEN DES STATIONAEREN ELEKTRISCHEN BLEIAKKUMULATORS, IHRE ENTSTEHUNG, FESTSTELLUNG, BESEITIGUNG, VERHUETUNG—Für Batterie besitzer, Betriebsleiter, Maschinenmeister und Installateure. By F. E. Kretzschmar. Munich and Berlin: R. Oldenbourg. Cloth; 5½x8½ in.; pp. 162; 83 text illustrations. Marks, 6, net; American price, $2.40, net.

ALTERNATING CURRENT DESIGN—By Julius Frith, M. Sc., M. I. E. E.; Consulting Engineer; Special Lecturer in Electrical Design in the Manchester University. New York: D. Van Nostrand Co. Cloth; 5½x8½ in.; pp. 118; 27 text illustrations, $2, net.

Prof. Morse's very interesting little book would be much more readable if the chapters were arranged in a different order. For example, the average reader and especially the student would like to begin with the chapter on "Commercial Types" much better than with the one on "Some Electrochemical Fundamentals." Abstract chemical equations, even when given with an immediate application in view, mean very little unless the reader can visualize the apparatus in which the chemical reactions occur. "The concrete before the abstract" is the slogan of modern pedagogy and in this case it means "the battery before the chemical reaction." Suppose, then, that we examine the book in the order in which we shall most enjoy it, just as in Mark Twain's autobiography the incidents were put down in the order in which the author most liked to recall them.

In Chapter XVII a number of applications of the storage battery are given with illustrated descriptions of different forms of plates. It is evident from these that the battery occupies a large field and a growing one. The most important function of the battery is stated to be "stand-by" service to insure continuity of operation of lighting and power circuits. Other applications are found in power houses where the batteries help out at times of overload, in electric vehicles such as trucks, run-abouts and even small cars, in train lighting, in submarine boat propulsion (during submersion), etc. These classes of service require different types of plate construction, a most important feature of such construction being the provision of a surface proportionate to the rate at which the battery must be charged and discharged. The following useful table shows the "weight efficiency" of various makes of paste batteries.

*Head Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

American, Standard Plates, 7½-8½ watt-hr. per lb.
American, Light, high capacity, 10½ watt-hr. per lb.
Edison, 12½ watt-hr. per lb.
European, Medium, 11 watt-hr. per lb.
European, Light, 14 watt-hr. per lb.

The weight efficiency is affected by the rates of charge and discharge, as is indicated by the author's statement that each cell of a battery, such as would be used in a large power plant, might contain 75 to 100 plates each, say, 18 in. square. This battery would give 2000 amp. for eight hours (16,000 amp.-hr.), 4000 amp. for three hours, 8000 amp. for one hour, 16,000 amp. for 20 minutes, or 32,000 amp. for five minutes (2666 amp.-hr.). The weight efficiencies given in the table undoubtedly refer to an eight-hour discharge rate, although this is not stated.

Several chapters of the book are devoted to the construction and "formation" of active material on Planté and pasted plates, and the applicability of these types of plate to various kinds of service are pointed out. Battery-plate diseases and their prevention and cure are taken up in a practical way and the general physical characteristics of storage batteries are summarized. All of this and the material described in the above paragraphs are of a practical nature and can be followed without any considerable knowledge of chemistry. The remainder, the first 171 pages, is more theoretical.

Taking up now the chapters on the chemistry of the lead cell, one is at first surprised that there is so much theory connected with the apparently simple, unobtrusive lead storage cell. Two sets of lead plates suspended in dilute sulphuric acid look simple enough. We find, however, that the reactions connected with charge and discharge are complicated and a number of fundamental chemical and physical laws underly them. Prof. Morse has done the students of the storage battery good service in putting down the results of his study and experience. He has chemically analyzed numerous samples of active materials and of solutions and has thus become familiar with the actual conditions met with in practice. While the chemical formulas given are not elaborate, the explanations cannot be followed without knowledge of the elements of chemistry. The author, however, begins with first principles of electrochemistry and defines the terms used therein, such as anode, cathode, ion, electrolyte, etc. He then takes up a few reactions and illustrates them numerically. He states a few queries, which are later answered, such as the following: "How can storage plants keep their shape, i.e., how does it happen that a battery can be charged and discharged thousands of times without much growth of 'trees' or 'sponge'?" "How can a cell remain on open-circuit without discharging itself?" These are pertinent questions and to answer them requires explanation of several important laws, which the author gives as simply as the nature of the subject will permit. The explanations are illustrated with numerous curves plotted from experimental data and having therefore considerable reference value.

Mechanically, Prof. Morse's book is a credit to author and publisher. It is of convenient size, well printed and illustrated and it is sold at a reasonable price. Its contents are a good combination of theory and practice with a leaning toward the theory. This is well, as Lyndon's "Storage Battery Engineering" and a small number of less comprehensive books give more weight to the practical aspects of storage-battery operation.

Mr. Kretzschmar has produced an excellent manual on the care of lead accumulators. It is quite different in plan and purpose from Prof. Morse's book. It is essentially a practical book abounding in facts regarding lead accumulators, evidently collected from observation and analysis of batteries in all stages of health and disease. Although a book on battery pathology, its purpose is to teach how to prevent unnecessary deterioration as well as to eradicate the effects of neglect.

As the author indicates, batteries are of such a nature that they are especially liable to neglect. Their nature is quite different from that of electrical machines which are easy to inspect and which, as a rule, receive reasonable attention. Even if such machines are neglected the results are not as serious as in the case of the battery. Among the infractions of the proper operating rules the following may be mentioned as typical: Too little charge, too lengthy charge or charge with excessive current, too little or too great discharge, short circuit, the use of improper acid-solution density, etc. In addition to these and other real causes of trouble the author also cites a number of causes of apparent deterioration which are not inherent in the battery, chiefly faulty details of operation which affect its output temporarily. For example, high resistance in the connecting circuits causes loss of voltage not to be charged against the battery; cold electrolyte prevents vigorous chemical action; incorrect measuring instruments give a wrong impression of the battery performance.

Having taken these matters up in detail with illustrations based on experimental data, the author next discusses the various tests which are helpful in locating the causes of poor results. The appearance of the plates and solution, the condition of active material and electrolyte as determined by chemical analysis and physical tests, and electrical measurements of all sorts, are shown to be useful for purposes of diagnosis. Such diagnosis leads to simple corrective

operations which are described in considerable detail.

The last part of the book deals with correct and scientific methods of battery handling by means of which discouraging troubles may be prevented. The selection of proper quarters, the provision of good ventilation, the use of good materials for solutions, the employment of suitable indicators of charge and discharge, the following of certain simple rules regarding rates and amounts of charge and discharge, etc., are mentioned as necessary for the best results. Of the rules just referred to 13 are given at the close of the book, with a warning that the proper care of a battery is not easy, and that only by bestowing the same affection and care upon his batteries as he does upon his machines can the owner expect to secure long life of the active materials.

The notes on alternating current design which Mr. Frith has set down and the publisher has issued in book form under an imposing title indicate that the author knows the subject in a practical way. He has, however, done little more than jot down a few suggestions in a very large and extremely complicated field. It is true that much of the commercial designing of electrical machinery is done now in a routine fashion largely as a clerical matter, but back of this must be the master designers who either combine intuition with large experience or apply the underlying theory with trained judgment. When these real designers attempt to put their knowledge into tangible form for the benefit of others they attempt a very difficult task, because intuition and judgment cannot be expressed except in their natural concrete product.

Mr. Frith states that he

> hopes the book will be useful alike to students and to those engaged in works, and he sometimes dares to hope that his brother designers will find on one or two things presented in a new light which may stimulate them ever whilst disagreeing.

This quotation indicates at once an ignoring of a fundamental principle of writing, namely, definiteness of audience. The style of the text shows that it is intended for beginners; otherwise, why are some of the simple fundamentals of alternating currents touched upon? And yet most of the really important statements regarding design could only be understood by one who is already somewhat of a designer. The reading matter looks easy on account of the absence of mathematics, but it is a delusion to believe that a student is going to get anything out of such statements as these on leakage flux in alternators:

> The next flux to consider is the stator leakage flux, i. e., that flux which surrounds the stator conductors simply from their own magnetizing force. That this flux is at right angles to the position of the maximum current is shown by the sketch (Fig. 6). (The figure shows a mysterious free-hand spiral with some crosses and circles and a couple of arrows pointing at right angles. How this can be expected to conjure up in the mind of the student what the author intends is difficult for a teacher to see.—H. H. N.)
>
> The stator leakage flux runs along the roofs of the stator teeth and crosses the air space to the magnets; at least, this is the final result. If the fluxes could be built up separately, the leakage flux would first of all travel along the roofs of the stator teeth and enter the stator, and return by the iron at the back of the stator; then the magnet flux would cross the air space, and part of it, combining with the leakage flux, would form the true stator flux at the back of the stator conductors, and part of it would return to the magnet circuit via the roofs of the slots, combining with the other part of the leakage flux.

This is the sort of information which "goes in at one ear and out at the other" because it is so intangible that the untrained mind cannot get hold of it. The trained mind knows it already and so, of course, is not interested. It is only fair to the author to call attention to the fact that he has given several examples of actual design with numerical data. These, however, have merely reference value and show that he knows how to design machines. They cannot possibly teach others to do the same unless the others are willing to be mere imitators.

Taking up the mechanical and literary construction of the book in detail, it will be noted first that it contains 113 pages exclusive of a two-page appendix and a two-page index. The use of large type, well leaded, permits the stretching of the copy to this limit, while the thick paper gives a bulk within book range. There are 24 chapters ranging in length from four to 10 pages each, including some which do not bear directly on the subject. After 21 pages (three chapters) of preliminary discussion of the theory of alternating currents, armature reaction in alternators, and the relation of dimensions to output, a 250-kw. alternator design is worked out numerically. Nine chapters later a second alternator design is given. A sample induction-motor design follows a chapter on induction-motor theory, and the transformer is similarly treated. The theory of transmission-line design, with reference tables, occupies nine pages. In addition some sundry matters are touched upon.

These comments are intended merely to indicate that when Mr. Frith wrote this book he did not realize what a task he had on hand. Much work must be done upon it before it realizes his ideal as stated in the preface.

One of the many recent newly established journals is *Human Engineering*, a quarterly which appeared for the third time in April, 1912. It is edited by Dr. Winthrop Talbot (100 St. Clair Ave., N. W., Cleveland, Ohio) and is described as "A Magazine for Employers published to provide a means of exchanging Experiences on the Human side of Industry and a Forum for the discussion of the Conservation of Human Energy."

ESSENTIAL POINTS GOVERNING THE FINANCIAL VALUE OF AN ENGINEERING PROPERTY—By Schuyler R. Schaff, C. E. New York: The Author (5 Beekman St.). Cloth; 4x6½ in.; pp. 87. $1, net.

Practically every class of investment, except those of a purely mercantile nature, require the services of an engineer and in many cases the degree of success of, the application of engineering talent marks the difference between failure and a fair return on the property. This little book is intended to inform the investor in certain types of property of the precise relation of the engineer to that property, so that he may realize the value of engineering services and the necessity for care in selecting the particular engineer for the work. The classes taken up include water supply, railroads, hydraulic power, irrigation, drainage, bridges, viaducts and miscellaneous structures.

TECHNOLOGIC PAPERS OF THE BUREAU OF STANDARDS—S. W. Stratton, Director. Washington, D. C.: Pub. Doc. Paper; 7x10 in.

No. 2: The Strength of Reinforced Concrete Beams; Results of Tests of 333 Beams (First Series). By Richard L. Humphrey and Louis H. Losse. [June 27, 1911.] Pp. 200; 45 text figures.

No. 3: Tests of the Absorptive and Permeable Properties of Portland Cement, Mortars and Concretes, Together with Tests of Damp-Proofing and Waterproofing Compounds and Materials. By Rudolph J. Wig, Associate Engineer-Physicist, and P. H. Bates, Chemist, Bureau of Standards. [Aug. 22, 1911.] Pp. 127; 53 text figures.

The two bulletins noted above give the results of a portion of the tests made on concrete materials at the Structural Laboratory, at St. Louis, some years ago. The data of these tests were transmitted to the U. S. Bureau of Standards when that bureau took over the work of the Structural Materials Laboratory which, up to that time, had been under the direction of the U. S. Geological Survey. The program of tests outlined at St. Louis was very complete and the method of carrying it out gave results far better than the usual tests carried on in college laboratories where the work is, as a rule, disjointed. Bulletin No. 3 was abstracted in ENGINEERING NEWS, May 2, 1912, and Bulletin No. 2 in ENGINEERING NEWS, May 9, 1912.

THE AMERICAN GOVERNMENT—By Frederic J. Haskin. Philadelphia and London: J. B. Lippincott Co. Cloth; 5x8 in.; pp. 398; 24 illustrations. $1.

A brief popular review of the activities of all of the major and most of the minor branches of the federal government is here presented. Beginning with the president, continuing with the various departments and department bureaus, Congress and the courts, the volume closes with an account of the Pan-American Union, a description of the national capital and some remarks on national political campaigns. A large amount of information is presented in an interesting manner. The Reclamation Service, Bureau of Standards, Geological Survey and the Panama Canal are covered.

A New Edition of a British Book on Refrigeration

Reviewed by J. C. BERTSCH*

REFRIGERATION, COLD STORAGE AND ICE MAKING — A Practical Treatise on the Art and Science of Refrigeration. With which is incorporated "Refrigerating and Ice-Making Machinery"—By A. J. Wallis-Taylor, C. E., Assoc. M. Inst. C. E.; Author of "The Pocket-Book of Refrigeration and Ice-Making," etc., Third edition, thoroughly revised. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 5½x9 in.; pp. xxiii + 632; 414 text illustrations. $4.50, net.

This is the latest book on refrigeration, being closed by the author in December, 1911. The sub-title is, "A Practical Treatise on the Art and Science of Refrigeration * * * Third Edition, Thoroughly Revised." A careful review of its contents, solely from the viewpoint of the present state of the art of refrigeration in the United States, shows that the book is incomplete and a great deal of its contents entirely out of date.

The first edition of the work was favorably received in this country, because at that time hardly any similar books in the English language had been written, and the art and science of refrigeration were not as well developed as they are at the present time. But since the appearance of the first edition several books on refrigeration have been written, among them:† "Modern Refrigerating Machinery," by Prof. Hans Lorenz; "Refrigeration, an Elementary Textbook," by J. W. Anderson; "Machinery for Refrigeration," by Norman Selfe; "Reports of the First and Second International Congress of Refrigerating Industries" (Paris, 1908, and Vienna, 1910).

These books and report cover the field so well and give so accurate accounts of the most modern methods and machinery for refrigeration, that the third edition of the book now before us makes a poor showing, particularly from the American viewpoint.

The introduction to the volume consists merely of statistics of the trade in fresh provisions in England, from 1891 to 1910. Chapter II, on the Theory and Practice of Mechanical Refrigeration, is composed of quotations of several authorities on the theory of heat, an explanation of the laws of Mariotte, Joule, Charles and Gay Lussac, and a classification of the methods and machines used for refrigeration into the five principal processes: Liquefaction (cold mixtures), Vacuum, Compression, Absorption and Cold Air. The third and fourth chapters treat the liquefaction and the vacuum process briefly and are of only historical value.

Chapters V, VI and VII, with a total of 117 pages, deal with the Compression process, the most important for practical work. After a very good description of the cycle of operation, the author describes at length the ether machines of Perkins, Twining, Harrison and Tellier. In spite of the fact that the ether machines have been out of use for many years they are minutely described and illustrated. On page 119 we read: "the manufacture of machines of this type has been continued successfully up to the present day." This is striking after the statement previously made (p. 117) * * * "the large size of the compressor required, about *seventeen* times that of an ammonia compressor of the same capacity." On page 44 the author refers to an American machine, with terms indicating its present use, of which the present generation was never aware. This is Van der Weyde's naphtha, gasoline, rhigoline or chimogene machine, mentioned probably in some old patent letter, but really too old for a practical treatise revised in 1911. Then come Pictet's sulphur dioxide and Windhausen's carbon dioxide machines, all now out of date, but nevertheless fully described and illustrated.

With Chapter VI begin the ammonia compression machines. After giving the properties of ammonia and the cycle of operation, the author describes several compression machines. He devotes about ten pages to the long out-of-date De La Vergne oil-seal compressor. Then comes the Frick machine (five pages), the Enock compressor (nine pages). It is painful to note that barely three pages are given to the Linde compressor, although Linde was the father of the practical ammonia machine. This section is introduced by the statement: "The ammonia compression machines designed by Carl Linde, and first patented in 1870, are extensively used, and this type of machines is said to give very good results." The results of a test made in 1886 are given, which in itself shows how imperfectly this edition has been revised. Among other builders of machines of American origin are mentioned The Vilter Mfg. Co. and the Triumph Ice Machine Co. The old Boyle machine is also mentioned. Then follow several dead issues, like the compound compressor of the York Mfg. Co., not built for about 15 years; the machines of Geo. Challoner, Sons & Co. and the A. H. Barber Mfg. Co., both concerns out of business for many years. Finally the methyl chloride, sulphurous acid and carbonic acid machines are described at length, among them those of Kroschell Brothers and the Cochran Co.

Instead of continuing the description of the processes in the order of classification given in Chapter II, the author next deals with condensers and water coolers (21 pages), simply accounting for the well known home and foreign constructions. Then comes the absorption process, but only old types of machines are mentioned and no reference whatever is made to the exhaust steam and combination absorption systems. The chapter on the cold-air process is supported by references dating back to 1881. About this process Prof. Hans Lorenz in his "Modern Refrigerating Machines," says correctly: "These old-fashioned machines are occasionally described in detail in some of the latest handbooks, without the authors daring to pass the death-sentence on them for their notoriously small value."

Chapter XI describes and illustrates the well known Triumph, Frick and De La Vergne fittings and compressor valves. Chapters XII to XV are devoted to Cold-Storage Refrigeration. Ammonia and brine-circulation, room piping, hoisting and conveying machinery, ventilation and insulation are described, but nothing new appears in these chapters, which contain abstracts from Prof. Siebel's "Compend" of 1899, and many abstracts from Madison Cooper's "Practical Cold Storage." Other references from papers read in 1881 and 1894, with a few of 1901, make up the contents of these chapters. Marine Refrigeration and Refrigeration in Dairies both deal strictly with the practice in England, but contain interesting data. Chapter XVIII treats Refrigeration in Industrial Establishments, such as chocolate factories, breweries and glue works, also for tunnelling, shaft sinking, blast furnaces and so on. The application of refrigeration in each industry is merely touched, and most of the references date back to 1886 and 1895.

The chapter on Ice Making is of little interest in this country (like all books on ice making written by European authors), because the methods used and ice produced in Europe could not be employed or marketed in this country.

The chapter dealing with the management and testing of refrigerating machines, calculation of efficiency and interpretation of the compressor indicator cards contains much interesting matter and some good pointers. The cost of working refrigerating plants is treated on in Chapter XXI, but as the costs are largely based on references and test of the years 1882 and 1886, excepting the tables of Frick Co. and Triumph Ice Machine Co., which are also very old, the data figures are of no practical value.

The concluding chapter, with 14 pages, is entitled "The Production of Very Low Temperatures" (Liquid Air). While it contains nothing new, it is the only chapter which gives the known facts in an impartial manner. It is quite in contrast with all of the other chapters, in which only the product of a few favored concerns are enumerated.

The work of the International Congresses of Refrigeration in Paris and

*Refrigerating Engineer, Fort Worth, Tex.

†The first two of these books were reviewed by Mr. Bertsch in our issues of Apr. 12, 1906, p. 428; July 16, 1908, p. 77. —Editor

Vienna is not mentioned at all, neither could the reviewer find any reference to American distilling apparatus, the flooding system of refrigeration, the rotary compressor and many other subjects which deserve mention. In short and finally, if one anxious to learn of the very latest in the art of refrigeration should happen to be deceived by the date of publication of this book (1912) and by the claim of a "thoroughly revised third edition," he will be badly disappointed by finding statements, opinions and tests dating from 1881 to 1895, instead of accounts of the most advanced methods of the past few years.

Cyanide Practice

Reviewed by F. W. TRAPHAGEN*

TEXT BOOK OF CYANIDE PRACTICE —By H. W. MacFarren, Author of "Practical Stamp Milling and Amalgamation," "Mining Law for the Prospector, Miner and Engineer." New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. 291; 32 text illustrations. $3, net.

The author has given us a practical handbook of the cyanide industry, especially valuable to the technical chemist who has not had experience in practical cyanidation and to the practical millman who has had little training in chemistry. While there is nothing new in the book, the material is very well selected and arranged. The most uptodate practice is given and the illustrations are especially good.

Mr. MacFarren has the happy faculty of presenting things clearly and concisely and this, his latest book, will surely be welcomed by those who care to have in compact form a description of the latest and best cyanide practice.

While the book as a whole is excellent, there are some things in it which show the need of more careful editing. Surely Mr. MacFarren did not mean this: "The solution of silver from the silver sulphide (Ag_2S) — the principal silver mineral worked by cyanidation—proceeds through the decomposition of the sulphide by cyanide, as:

$$Ag_2S + 4\ KCN = 2\ KAg\ (CN)_2 + K_2S."$$

In which 1 *part cyanide dissolves* 0.414 *part of silver, or one-half as much as of native silver."* (Italics reviewer's) p. 19.

On p. 11 the following reaction for native silver is given:

$$2\ Ag + 4\ KCN + O + H_2O = 2\ KAg\ (CN)_2 + 2\ KOH.$$

Both of the reactions quoted are correct and in each the same weight of cyanide is required for the solution of the silver; in other words, two molecules, in round number 130 parts by weight, for the solution of 1 atom, 108 parts by weight, of silver.

The formula for ammonium cyanide is wrongly given on p. 9 as NH_2CN. On p. 244, "Travenner" should be Taverner. The expression "more preferably" does not sound well, and a "hypodermic injection under the skin" seems redundant.

The chapters on percolation, agitation, filtration and precipitation are exceptionally good, and the book taken as a whole is a notable addition to the literature of ore treatment.

*Professor of Metallurgy and Assaying, Colorado School of Mines, Golden, Colo.

An Intensive Study of Epidemic Diarrhoea

OBSERVATIONS UPON THE NATURAL HISTORY OF EPIDEMIC DIARRHOEA—By O. H. Peters, M. D., D. P. H. Cambridge [England]: University Press. [New York: G. P. Putnam's Sons.] Cloth; 7x10¼ in.; pp. 177; 9 charts and 27 tables. 7s., net; American price, $2.80, net.

An intensive study of epidemic diarrhœa was made by the author at Mansfield, England, in 1908. The conclusions drawn were to some extent confirmed by observations made in 1909. A house-to-house investigation was conducted in two sections of the borough which presented some important contrasts. Minor studies were made in other sections.

The population of Mansfield was 21,400 in 1901 and was [estimated] 32,500 in 1908. "The people of the town are a young, healthy stock, with a high birth rate, 33.6 in 1908; and a relatively low death rate, 13.8 in 1908."

The two areas studied in 1908 had a combined population of about 2000, living in 413 houses. The author visited 391 of the 413 houses from May to November, 1908, and recorded 390 separate attacks of epidemic diarrhœa. He also obtained details as to "dates of attack, age incidence and age constitution of population, milk supply, sanitary arrangements, proximity to stables, and fly nuisance," as well as meteorological and other data believed to be relevant.

After statistical analysis and textual comment that go into minute details the author concludes that "infection within the home is probably the commonest method of contracting the disease," and that this infection is due to the dirty habits of the individual household, particularly as regards failure to properly care for the "motions" (dejecta) of the patients. The unquestionable spread of the disease from house to house, as shown by "clumping" of infected houses, is attributed largely to common backyards, which have a tendency to become as filthy as the area directly appertaining to the filthiest household, and in any event afford ready means of inter-infection of families.

A notable conclusion drawn from the study is that "the milk-supply apparently plays no part, unless one of a general kind, in introducing diarrhœa into the home." The author states that "boiling the cow's milk," which seems to be a general practice in Mansfield, "gave no protection whatever."

Considerable space is given to a comparative study of 4-ft. ground temperature, fly-prevalence and diarrhœa curves, but while these follow each other so closely as to suggest relationship they lead to no definite practical recommendations for remedial measures that promise to be markedly effective.

Besides the preventive measures already mentioned, the author recommends the notification or reporting of diarrhœa to health authorities, and isolation of cases, as "generally practicable to some slight extent."

Commendable as Dr. Peters' studies are for laborious detail and careful weighing of data it seems desirable to have them continued at Mansfield and duplicated elsewhere. The incidence of disease from year to year and from city to city is subject to marked variations. In some communities the milk supply is not "boiled," or even pasteurized at low temperatures. Housing conditions vary widely, as do other factors which enter into infant mortality, among which none is perhaps more important than the percentage of mothers of infants and young children employed in gainful occupations outside the home—which was small at Mansfield.

THE PRINCIPLES OF SPECIFICATION AND AGREEMENT WRITING—By C. R. Young, B. A. Sc., Assoc. M. Can. Soc. C. E.; Consulting Structural Engineer; Lecturer in Structural Engineering, University of Toronto. Reprinted from "The Canadian Engineer." Toronto: The Canadian Engineer, 62 Church St. Paper; 6x9 in.; pp. 47. 25c., net.

This pamphlet is a reprint from an article which appeared in the "Canadian Engineer." It is a very complete discussion of the fundamental principles of specification writing. It does not attempt to go into the details of a specification of any particular material or structure, but takes up in sequence the various features which such a specification should have. For a short treatment of the subject it is very complete.

REPORT OF THE BUREAU OF BUILDINGS OF THE CITY OF NEW YORK FOR THE BOROUGH OF MANHATTAN, 1910. Paper; 6¾x10 in.; pp. 85; illustrated. The Bureau of Buildings, 220 Fourth Ave., New York City.

This report, while issued after considerable delay, is so much in advance of what has previously been attempted by the Bureau in the way of an annual report that the changes will be greatly appreciated by those interested in city buildings. All possible statistical matter is contained in the report, both descriptively and in tabulation. The chief accidents which occurred under the Bureau's observation are reviewed and illustrated. Two regulations issued by the Bureau during the year are codified and a list of approved fireproof constructions is given.

Concrete Buildings

REINFORCED-CONCRETE BUILDINGS—A Treatise on the History, Patents, Design and Erection of the Principal Parts Entering into a Modern Reinforced-Concrete Building. By Ernest L. Ransome and Alexis Saurbrey, Assoc. Ms. Am. Soc. C. E., President and Consulting Engineer, and Manager and Chief Engineer (respectively) of the Ransome Engineering Co. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. 235; 176 text figures. $2.50, net.

No book precisely similar to this one has appeared among the voluminous writings on concrete and reinforced concrete. It is an attempt to present in an expository manner the salient features of the design and construction of reinforced-concrete buildings. It does not attempt to go into the nature of the materials that make up these buildings nor into the elementary principles of structural design, but rather to present for competent engineers the result of experience and study during the past decade in the construction of the important concrete buildings. As the authors say, in their preface, "the ultimate result of the analysis has been treated in greater detail than the derivation itself. . . . . All references to weight and dimensions, earth pressure, etc., have been avoided. The practising engineer, the contractor, or even the college student should look for such matters in special 'pocket-books' and he must not expect the reinforced-concrete book to furnish a complete encyclopedia on civil and hydraulic engineering."

Contrary to the general practice of joint authorship, the two authors have divided their respective work into different sections, of which due acknowledgement is made. Part I, "Contribution to the History of Reinforced-Concrete Construction," contains a personal reminiscence by Mr. Ransome and a discussion of basic patents and similar records by Mr. Saurbrey. Part II, entirely by Mr. Saurbrey, is entitled, "Rational Design of Reinforced-Concrete Building," and Part III, for which joint responsibility is accepted, is headed "Practical Construction."

Mr. Ransome's reminiscences are particularly interesting. Probably there is no other man in the industry so qualified to tell of its early days, and of the detailed steps in its progress. His story is admirably rounded out by the succeeding chapters describing the main patents which have marked important steps forward in the art. We fail to understand however, why in this latter section, all reference to the very important flat slab floor has been omitted.

The portion on design is a plain statement of the requirements of the various members which go to make up a reinforced-concrete building, arranged in quite rational fashion. Starting with the basic assumption that the adhesion of the steel to the concrete is the fundamental necessity for reinforced concrete, the theory is developed through adhesion, compression and lateral expansion, to bending, which forms the principal portion of the section. The theory of bending presented is the common one, though the final formulas arrived at are somewhat different than those usually employed. While the authors seem to think that these formulas are of considerably greater utility than the ordinary ones, we fail to see that any great improvement over the common straight-line formulas as generally accepted has been reached. Particularly we would criticize the use of a system of notation entirely different from the one advocated in the report of the Joint Committee on Concrete and Reinforced Concrete. The necessity for a standard notation is so apparent that we think no argument for it is required here and it indicates a peculiar obstinacy on the part of an author to set up an entirely different system from the one promulgated by a representative committee and gradually being accepted in all scientific work.

The section on practical construction is particularly good on account of its simplicity. It takes up in order, materials of construction, floor systems, foundations, finishing operations, fireproofing and fires, repairs to existing buildings, accidents, superintendents' specifications, the relation of the engineer to concrete work, and the theory of beams as illustrated by tests.

In the section on floor systems, the unit system is unduly magnified to the exclusion of other systems. The chapter on accidents is quite incomplete in its description of the particular accident, but very good in its conclusions, which are short enough to reprint here, as follows:

> It is, however, confidently believed that serious failures of reinforced-concrete buildings will not occur if the following simple precautions are taken: Tie all steel bars into the next span. Use closely spaced hooks in all columns. See that the concrete is hard before the shores are removed.

The final chapter on tests takes the salient features of a number of tests and applies their results to the principles of design as exemplified in the preceding chapters. It has, however, the same fault as noted above in the floor-system chapter; namely, too great attention to the separately molded system of floor construction.

As a whole the book is a very good addition to the subject of reinforced concrete. The method of treatment is very clear throughout and there is a pleasant absence of confused statements and unnecessary verbiage. It is a matter of taste, perhaps, but we would have thought more of the first section of the book, if the authors had not so often called attention to the great number of patents held by Mr. Ransome on the various details of construction described. After reading the book, we have almost come to believe that Mr. Ransome should collect a royalty on every piece of concrete construction now being placed in this country. In the first section on patents, too, there might have been more care put on the perspective drawings, which often fail to show clearly what they are intended to represent.

Floods and Storage Reservoirs

FLOOD COMMISSION OF PITTSBURGH, PENN.—Report, 1911. Containing Results of Surveys, Investigations and Studies Made by the Commission. Pittsburgh, Penn.: The Commission. [W. M. Jacoby, Executive Secretary.] Cloth; 7½x10½ in.; pp. 452; two maps in pocket of cover; many folding plates. Portfolio containing 14 folding maps.

We advise every person who reads this and who is responsible for the maintenance of an engineering reference library wherever located to forthwith apply to the Pittsburgh Flood Commission for a copy of its report. So far as our knowledge extends, this is by all odds the most valuable contribution to engineering literature on the subject of river regulation by storage reservoirs that has ever appeared. It is, of course, true that a vast amount of matter has been written and printed regarding river regulation and flood prevention. In fact, an appendix of 36 pages at the end of this volume is devoted to an exhaustive bibliography of flood literature compiled by the Technology Department of the Pittsburgh Carnegie Library. Nowhere else in the world, however, so far as we recall, has a project for river regulation by reservoir construction, on rivers of the size of the Allegheny and Monongahela ever been worked out in detail, as a practical engineering proposition, with ample funds to make complete surveys, plans and estimates.

Pittsburgh is not accustomed to doing things by halves. It is the rule rather than the exception in engineering enterprises that the least possible amount of money is spent on the original engineering investigation. People are generally parsimonious about spending money in preparatory work. Capitalists and investors will spend hundreds of thousands of dollars in actual construction without a question; but they will dole out most parsimoniously a few hundreds or thousands at the outset of an enterprise to find out whether the construction is justified and the way in which to construct most economically.

In this Pittsburgh flood-prevention investigation, however, the broad-gage business men at the head of the enterprise realized that the whole question turned upon its practicability from both the engineering and financial standpoints. This had to be thoroughly established by the best possible engineering data, fortified by all available information, or the city could not be safely advised to proceed with the enterprise. From various sources the Flood Commission of Pittsburgh has

raised over $124,000. Of this amount about $110,000 has been expended, $77,000 of which was spent on the engineering work.

In our issue of Nov. 9, 1911, we printed, from advance proofs of the first chapter of the report, the principal results of the commission's work. As our readers will recall, the investigation showed that while the flood damages at Pittsburgh in the last 10 years have amounted to over $12,000,000 and are likely to be much greater in the future, the city can be completely safeguarded against floods at a cost of about $20,000,000. This sum would be expended in constructing 17 storage reservoirs on the head waters of the Allegheny and Monongahela Rivers and in building a wall along the low-lying portions of the river bank within the cities of Pittsburgh and Allegheny.

In this estimate of cost no account whatever has been taken of the value of the water power that might be created by the construction of these storage reservoirs. It is, of course, true that the use of a reservoir for water power may conflict more or less with its use to prevent floods. In order that the reservoirs shall have maximum efficiency for flood prevention their basins must be kept empty as nearly as possible at all times, ready to receive the inflow from a sudden heavy rainfall. From the practical point of view, however, the use of a reservoir partly for power purposes and partly for flood prevention may be more profitable than either alone. In other words, if a considerable revenue can be obtained from the sale of stored water for power purposes, the city or whatever authority undertakes the construction of the reservoirs, could afford to build a larger number of greater size if revenue from the use of the stored water for power was available.

It is not our present purpose to abstract the contents of this report, however, but merely to call attention to its value to every engineer who may in future have placed before him similar problems to those which were handled by the engineers concerned in this investigation. To any such engineer this report will be an invaluable authority and guide; and it is for this reason that we repeat what we said at the outset that every engineering reference library making any pretensions to completeness should have a copy of this monumental report on its shelves.

PROCEEDINGS OF THE AMERICAN RAILWAY ENGINEERING ASSOCIATION. (13th Annual Convention)—Chicago. Paper; 6x9 in.; pp. 1234; illustrated. $5 ($5.50 cloth, $6 half morocco).

Two features of this volume, apart from the consideration of its contents, are the promptness of its issue (less than two months after the meeting), and its use of thin "India" paper. The thin paper makes it possible to present 1234 pages and all folding plates and diagrams in one volume of convenient size. The contents include the reports of the several committees, relating to railway engineering and construction, together with the discussions and other matter.

The Courts, the Constitution and Labor

THE LAW OF THE EMPLOYMENT OF LABOR—By Lindley D. Clark, LL. M. New York: The Macmillan Co. Cloth; 5½x8 in.; pp. 373. $1.60, net.

ATTITUDE OF AMERICAN COURTS IN LABOR CASES—A Study in Social Legislation. By George Gorham Groat, Ph. D. Being Vol. XLII, Columbia University Studies in History, Economics and Public Law; Edited by the Faculty of Political Science. New York: The University; Longmans, Green & Co., Agents. London: P. S. King & Son. Paper; 6½x9¾ in.; pp. 400. $2.50, net; cloth, $3, net.

In these days of strenuous activity to prove and to disprove the necessity and wisdom of the recall of judges and of judicial opinions, any thorough review of the attitude of the courts in any field of constitutional law can scarcely fail to be interesting. Since much of the present widespread dissatisfaction with the courts has arisen from cases involving the relations between capital and labor, the two volumes before us are timely. Each author, in accordance with widely different plans, has rendered a distinct service in the preparation of his book.

Mr. Clark, in his "Law of the Employment of Labor," presents in condensed form a classified digest of court decisions "intended primarily to interest the student" of labor conditions, but which will also have a "value as a legal handbook," "limited only by its brevity." Within these self-set limits the author appears to have done all that could be reasonably expected. The plan and the space limits combine to make the treatment so condensed and skeleton-like as to have little attraction for any but the special student and the lawyer, although it might well prove useful as a reference work to any employer or director of labor or labor leader who wished to post himself quickly on some phase or phases of the legal status of employers and employees.

"Attitude of American Courts in Labor Cases: A Study in Social Legislation," as might be inferred from its title and the fact that the author is a teacher and student of economics and sociology, follows quite different lines. The author warns his readers "not to consult these pages for information as to the exact status of the law in any particular jurisdiction," since the purpose of the book is rather "to set forth the various conflicting views that obtain." This purpose is achieved by liberal quotations from judicial decisions handed down by the courts of the several states and by the federal courts. Many of these decisions, when dealing with the same or similar issues, are utterly at variance with each other. Besides conflicting decisions, which until reversed become "the law" in the corresponding jurisdictions, the author quotes with equal freedom from dissenting opinions.

The method in this apparent madness is this: by presenting a confusing whirl of competing decisions, and subjecting them to interpretive comment, the author is able to show how largely each judge simply follows the individual bent of his own mind, as influenced by education, environment, and knowledge or lack of knowledge of the social and economic questions of the day, instead of deciding a case in accordance with any fixed principles of justice. One judge prefers to follow precedent, even if convinced that it is wrong, rather than shake public confidence in the stability of justice. Another judge is less a worshipper of precedent. Of two judges, one gives little or no and the other much weight to public opinion, or to the belief of many that the social and industrial changes of more than a century of marvelous growth make necessary a changed interpretation of a constitution written when none of the conditions now governing capital and labor existed. One judge interprets the constitutional guarantee of "life, liberty and property" wholly with regard to *property*, and another with *more* if seldom with *full* regard to *life*.

Among the carefully reasoned conclusions reached by the author in his closing chapter the following may be cited: Judges "must know society" as well as "the law"; law and constitutions are for society instead of the reverse being true; social justice and not merely individual justice is the thing sought in the twentieth century, and can be attained by a reasonable interpretation of constitutional phrases, in the light of the present conditions.

It is hardly necessary to say that to any ne interested in the live questions of the day, Prof. Groat's book will be interesting, stimulating and, unless he be unduly prejudiced, enlightening.

Labor legislation in the United States during 1911 is the subject which occupies the 500 or more pages of the bulletin of the Bureau of Labor (Washington, D. C.) for November, 1911 (issued in May, 1912). The legislation is reviewed and summarized in about 150 pages by Lindley B. Clark. A folding table presents the leading features of employers' liability legislation. The remainder of the bulletin is occupied by a reprint of the statutes passed by the various states arranged in alphabetical order by states and by the laws enacted by the United States. A cumulative index of labor laws and decisions relating thereto fills some 40 pages of the bulletin.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 30 cents per franc for French books, the extra allowances being for importation costs.]

THE ART OF ILLUMINATION—By Louis Bell, Ph. D., Fellow, American Academy of Arts and Sciences; M. A. I. E. E.; Past-President, The Illuminating Engineering Society; Vice-President, The Illuminating Engineering Society (London). Second edition, thoroughly revised, enlarged and reset. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. ix+353; 171 text figures. $2.50, net.

BRAZING AND SOLDERING—By James F. Hobart. Being No. 5 of a series of Practical Papers. Fifth edition, enlarged. New York: The Norman W. Henley Publishing Co. Paper; 5½x8 in.; pp. 51; 18 text figures. 25c., net.

CENTRIFUGAL PUMPING MACHINERY—The Theory and Practice of Centrifugal and Turbine Pumps. By Carl George de Laval, M. Am. Soc. M. E., Naval Architects and Marine Engineers, and Am. Soc. Naval Engineers. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. viii+184; 159 text figures; 19 tables. $3, net.

CONCRETE COSTS—Tables and Recommendations for Estimating the Time and Cost of Labor Operations in Concrete Construction and for Introducing Economical Methods of Management. By Frederick W. Taylor, M. E., Sc. D., and Sanford E. Thompson, S. B., M. Am. Soc. C. E.; Consulting Engineer. Authors of "A Treatise on Concrete, Plain and Reinforced." New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xxii+709; 82 text figures. $5, net (21/1, net).

CONCRETE WORKER'S REFERENCE BOOKS—By A. A. Houghton, Author of "Concrete from Sand Molds," "Ornamental Concrete without Molds," etc. No. 8: Concrete Bridges, Culverts and Sewers. No. 9: Constructing Concrete Porches. New York: The Norman W. Henley Publishing Co. Stiff paper; 5x7¼ in.; pp. 58 and 62, respectively; illustrated. 50c. each, net.

FIRE PREVENTION—A Treatise and Text Book on Making Life and Property Safe against Fire. For Inspectors, Fire Marshals, Business Men, Building Managers, Shop Foremen, Superintendents of Institutions, Janitors, Engineers, Matrons and Housekeepers. Written for "The Chief," the Government Weekly. By Peter Joseph McKeon, Consulting Expert in Fire Prevention. New York City: The Chief Publishing Co. Cloth; 6x9 in.; pp. 256; many text figures. $1.75, net.

HOUSE WIRING—A Treatise Describing and Illustrating Uptodate Methods of Installing Electric Light Wiring. By Thomas W. Poppe, Electrical Engineer and Contractor. New York: The Norman W. Henley Publishing Co. Linen; 4½x6½ in.; pp. 103; 74 text figures. 50c., net.

KNOTS, SPLICES AND ROPE WORK—A Practical Treatise Giving Directions for Making Useful and Ornamental Knots in Common Use, etc. By A. Hyatt Verrill, Editor Popular Science Dept., "American Boy Magazine." Cloth; 4½x7 in.; pp. 102; 148 text figures. 60c., net.

LOOSE-LEAF COVER FOR LABORATORY REPORT—Copyright, 1912, by S. E. Slocum, University of Cincinnati, Cincinnati, Ohio. Stiff paper; 8x10½ in.

THE MECHANICS OF BUILDING CONSTRUCTION—By Henry Adams, M. Inst. C. E., Inst. M. E., F. S. I., F. R. San. I., M. S. A., etc.; Examiner to the Board of Education (London). New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5½x9 in.; pp. xi+240; 590 text figures. $2, net.

MINING CONDITIONS UNDER THE CITY OF SCRANTON, Penn.—Report and Maps. By William Griffith and Eli T. Conner. Bulletin No. 25, Bureau of Mines; Joseph A. Holmes, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 89; illustrated. 25 maps in separate case.

THE NEW INTERNATIONAL YEAR BOOK — A Compendium of the World's Progress for the Year 1911. Frank Moore Colby, M. A., Editor; Allen Leon Churchill, Associate Editor. New York: Dodd, Mead & Co. Cloth; 7¼x10¼ in.; pp. viii+808; 8 maps and 46 text illustrations. $5, net.

NEW SOUTH WALES, DEPARTMENT OF PUBLIC WORKS—Report for Year Ended June 30, 1911. [Hon. Arthur Hill Griffith, M. L. A., Secretary]. Sydney: Pub. Doc. Paper; 8¼x13 in.; pp. 112; 12 plates, 1 map, 1 plan.

PUBLIC WORKS DEPARTMENT (MADRAS PRESIDENCY) — Administration Report for the Year 1910-1911. Part II—Irrigation. Madras: Pub. Doc. Boards; 8¼x13¼ in.; pp. 245; folding maps and diagrams. 3 rupees 10 annas (5/6); American price, $2.25, net.

RAILROAD COMMISSION OF NEVADA—Annual Report, 1911. E. H. Walker, Secretary. Carson City, Nevada: Pub. Doc. Paper; 6x9 in.; pp. 437.

RAILWAY TRANSPORTATION—A History of its Economics and of its Relation to the State. Based, with the author's permission, upon President Hadley's "Railroad Transportation: Its History and its Laws." By Charles Lee Raper, Professor of Economics, Dean of the Graduate School, University of North Carolina; Author of "The Principles of Wealth and Welfare," etc. New York and London: G. P. Putnam's Sons. Cloth; 5¼x8 in.; pp. xi+31. $1.50, net.

THE REGULATION OF MUNICIPAL UTILITIES — National Municipal League Series. Edited by Clyde Lyndon King, Ph. D. New York and London: D. Appleton & Co. Cloth; 5x7½ in.; pp. 404. $1.50, net.

THE RELATION BETWEEN THE PRECIPITATION OVER THE WATERSHED OF THE OHIO RIVER ABOVE AND THE STREAM-FLOW AT CINCINNATI—By J. Warren Smith, Professor of Meteorology. Prepared under direction of Willis L. Moore, Chief U. S. Weather Bureau. Bulletin No. 40, Weather Bureau, U. S. Dept. of Agriculture. Washington, D. C.: Pub. Doc. Paper; 6x9¼ in.; pp. 40; illustrated. 15c. per copy.

REPORT OF SUBSIDIZED RAILWAYS AND OTHER PUBLIC WORKS—Province of Nova Scotia, Sept. 30, 1911. By Roderick McColl, M. Can. Soc. C. E., Provincial Government Engineer, N. S. Halifax, N. S.: Pub. Doc., Dept. of Public Works. Paper; 6½x9¾ in.; pp. 70; illustrated.

SOME OBSERVATIONS IN REGARD TO WATER-WORKS PUMPING STATIONS—By Nicholas S. Hill, Jr., [100 William St., New York City]. With Discussion by Kenneth Allen. Reprinted from Proceedings for 1911, The Municipal Engineers of the City of New York; Paper No. 69. Paper; 6x9 in.; pp. 27; illustrated. Address the author.

STATE BOARD OF HEALTH OF OHIO—Annual Report for Year Ending Dec. 31, 1910. Columbus, Ohio: Pub. Doc. Cloth; 6½x9¾ in.; pp. 410.

STATE OF NEW YORK MUNICIPAL ACCOUNTS—Special Report by the State Comptroller (Wm. Sohmer). Transmitted to the Legislature, July 20, 1911. Albany, N. Y.: Pub. Doc. Paper; 5¾x9 in.; pp. 119.

STATE OF NEW YORK, PUBLIC SERVICE COMMISSION, SECOND DISTRICT—Annual Report for Year Ended Dec. 31, 1910. Abstracts of reports of corporations, electrical, gas, telephone. Albany, N. Y.: Pub. Doc. Cloth; 9¼x12½ in.; pp. 192.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1911—No. 34. Prepared by the Bureau of Statistics, under direction of Secretary of Commerce and Labor (Hon. Charles Nagel). Washington, D. C.: Pub. Doc. Cloth; 6x9 in.; pp. 803.

STATISTICS OF CITIES AND TOWNS OF IOWA—Fourth Annual Report of the Department of Finance and Municipal Accounts, for Fiscal Year Ending March 31, 1911. By Auditor of State John L. Bleakly. Des Moines, Ia.: Pub. Doc. Cloth; 6x9 in.; pp. 237.

STATISTICS OF RAILWAYS IN THE UNITED STATES—Annual Report for the Year Ending June 30, 1910. Prepared by the Division of Statistics, Interstate Commerce Commission. Washington, D. C.: Pub. Doc. Cloth; 5¾x9¾ in.; pp. 898; one folding map.

STEAMING TESTS OF COALS AND RELATED INVESTIGATIONS—Sept. 1, 1904, to December 31, 1908. By L. P. Breckenridge, Henry Kreisinger and Walter T. Ray. Bulletin 23, Department of the Interior, Bureau of Mines; Joseph A. Holmes, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. x+380; 94 text figures.

THE SUBWAYS AND TUNNELS OF NEW YORK: METHODS AND COSTS—With an Appendix on Tunneling Machinery and Methods and Tables of Engineering Data. By Gilbert H. Gilbert, Lucius I. Wightman and W. L. Saunders. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; p. xiv+372; many plates and text illustrations. $4, net (17/- net).

TECHNOLOGIC PAPERS OF THE BUREAU OF STANDARDS — S. W. Stratton, Director. No. 7: The Testing of Clay Refractories, with Special Reference to Their Load Carrying Capacity at Furnace Temperatures. By A. V. Bleininger, Ceramic Chemist, and G. H. Brown, Assistant Ceramic Chemist, Bureau of Standards. [Dec. 1, 1911]. Washington, D. C.: Pub. Doc. Paper; 7x10 in.; pp. 78; 30 text figures.

TESTS OF COLUMNS: AN INVESTIGATION OF THE VALUE OF CONCRETE AS REINFORCEMENT FOR STRUCTURAL STEEL COLUMNS—By Arthur N. Talbot and Arthur R. Lord. Bulletin No. 56, University of Illinois, Engineering Experiment Station. Urbana, Ill.: The University. London: Chapman & Hall, Ltd., European Agent. Paper; 6x9 in.; pp. 44; 20 text figures. 25c., net.

VALUATION OF PUBLIC UTILITY PROPERTIES—By Henry Floy, A. B., M. A., M. E., Consulting Engineer; M. Am. Inst. E. E., M. Am. Soc. C. E., etc. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in; pp. viii+390; 8 text figures; 45 tables. $5, net.

WATER-POWER DEVELOPMENT IN THE UNITED STATES—Part I.: Physical Conditions and Economic Aspects of Water Power. Part II: Concentration of Ownership and Control. Part III: Water Power and the Public. Report of the Commissioner of Corporations, Mar. 14, 1912. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. xx+220; 9 maps, 5 charts, and 25 tables.

WATER-SUPPLY PAPERS, U. S. GEOLOGICAL SURVEY—Department of the Interior; George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.

No. 280: Gaging Stations Maintained by the United States Geological Survey, 1888-1910, and Survey Publications Relating to Water Resources Compiled by B. D. Wood. Pp. 102.

No. 282: Surface Water Supply of the United States, 1910. Part II—South Atlantic Coast and Eastern Gulf of Mexico. Prepared under direction of M. O. Leighton, by M. R. Hall and J. G. Mathers. Pp. 109; illustrated.

WOODWORKING SAFEGUARDS — For the Prevention of Accidents in Lumbering and Woodworking Industries. By David Van Schaack, Director, Bureau of Inspection and Accident Prevention. Hartford, Conn.: Aetna Life Insurance Co., Accident and Liability Dept. Stiff paper; 6¾x9¾ in.; pp. 217; 320 text figures. $1, net.